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OF

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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THE JOURNAL
OF
THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

VOL. 35 JULY 1913 NUMBER 7

The Society's stock of Volume 6 of Transactions is entirely exhausted and to supply urgent demands copies will be purchased at five dollars per volume if delivered at the Society rooms prepaid and in good condition.

MEETING IN GERMANY

The trip to Germany so long planned for and so greatly anticipated by those who were able to accept the invitation of the Verein deutscher Ingenieure, began on June 10 with the sailing of the Victoria Luise from the Hamburg-American Line dock in Hoboken. News of its safe arrival in Hamburg on the afternoon of Thursday, June 19, is reported in a cable received a short time ago. The voyage was most enjoyable, sunshine and smooth seas favoring the travelers all the way and the many social features making the ship's company resemble a yachting party rather than an ordinary ocean trip. About 250 members and guests composed the German party, making up by far the greater portion of the passenger list. Fifty members and guests joined the party upon its arrival in Hamburg.

The Victoria Luise is one of the largest and finest cruising boats in the world, carrying only first-class passengers, and is admirably adapted to the needs of a large party. Immediately upon its arrival in Hamburg, it was scheduled to convey Kaiser Wilhelm and his royal party to the yacht races at Kiel.

Letters written just before the close of the trip across and

mailed at Cherbourg have been received just as The Journal is on the press and some account can here be given of the various events on shipboard. The first three days were fair with smooth seas and quite warm temperature in the gulf stream, and the succeeding days brought a freshening breeze with a somewhat choppy sea, though not of a nature to cause discomfort.

The Entertainment Committee, Prof. Arthur M. Greene, Jr., chairman, had arranged so full a program, to which the ship's company in general were invited, that almost every hour of the passage was eventful. Indeed, the person must have been indifferent who could long remain in his steamer chair, oblivious to the jollity in progress.

The first gathering was held on Wednesday evening, the second day out, when the ship's officers and the present and past officers of the Society received the company, after which was the all-important function of swearing in the special and secret police, with Frank B. Gilbreth as chief. In his speech of acceptance, Mr. Gilbreth reverted for a moment to thoughts of members left on the home shore, and proposed sending a congratulatory wireless to James M. Dodge, who on the day previous had received the degree of Doctor of Engineering at Stevens Institute of Technology.

Unfortunately the chief's reign in the interest of good order was somewhat checked on Friday evening, when he was himself arrested on several serious charges and brought before the court, Worcester R. Warner, presiding judge, for mock trial. One of the indictments was that he had permitted passengers to exceed the speed limit of twelve knots an hour on the deck in the early morning. Several of the leading engineering experts of the country were called upon to testify and much scientific evidence was educed. The jury, however, disagreed, but since they believed that some one should be convicted, the chief's deputies were sentenced instead.

The strongest of the entertainment features were the lectures given on different evenings, bearing upon the land trip to come. The first, by Henry Hess, traced the history of the German Empire and the steps which have led to the unification of the states, and to the present industrial activity. By several pertinent examples, he showed his hearers that much that was called modern in engineering was really perhaps centuries old.

A second lecture on German Art, by Prof. H. E. Clifford, gave in a delightful manner a summary of the work of German artists,

contending that Germany has recently developed no characteristic art in paintings, but instead has easily become the leader in the world's music.

The third lecture, by Worcester R. Warner, on German Cities, took the audience through the cities of the scheduled trip by the aid of lantern slides and gave figures upon their growth and the commercial conditions of Germany. The concluding lecture on the German Educational System, by Prof. C. R. Richards, was arranged for Wednesday evening, June 18, and had not yet been given when the letter was written.

On Monday, June 16, the twenty-fifth anniversary of the accession of Emperor Wilhelm II to the throne was celebrated throughout Germany, and in honor of the occasion, Captain M. Meyer of the Victoria Luise gave a Silver Jubilee dinner on Sunday night, June 15. The dinner was excellent, and the saloon handsomely decorated for the occasion. The captain in a brief speech spoke feelingly of the three emperors, Wilhelm I, Frederick, and Wilhelm II., and said that Germans are everywhere and would do homage throughout the world to the present emperor.

Prof. Wm. H. Carpenter, vice-president of Columbia University and president of the Germanic Society of America, who was a passenger on the ship, appropriately gave the response. He dwelt on the supposed warlike tendencies of Wilhelm II, his love of pomp and ceremony, and of the fears of the world that it meant war and a military rule when he came to the throne. Instead, his strengthening of the military arm of Germany has been for the purpose of maintaining German unity and fostering industrial development under the assurance of peace. He contrasted the industrial activity of today with the lack of it thirty-five years ago when he himself was a German student.

This dinner, the regular "Captain's dinner," which came later, and an admirable Sunday service, all added pleasure to the company's pastime. Numerous other events, sports, games and contests and even a baby show aroused an interest which would not be possible on land where there are conflicting and greater outside interests. Perhaps as much interest was felt in the Wireless Contest as in any one thing. This required the writing of a message of twenty words in rhyme, and from the 85 entries two were declared to be equally good, so that the judges could not decide between them. The winning gentleman withdrew in favor of the lady, who was permitted as a reward to send a gen-

nine message of ten words. Two dances were given during the trip, one of them a cotillion.

The best evidence of the happy frame of mind of all concerned is contained in the following resolution which those of the company not members of the Society presented to the party:

"As passengers on board this ship,
We thank the engineers,
For all they did to make this trip
The pleasantest in years.

"They helped us pass the time away
And made dull hours short,
With games and contests, dance and play,
And every kind of sport.

"Whoe'er we are, where'er we sit,
Or what our name may be,
They gave us all a hearty bid
To share their jollity.

"Full many of the passengers
Joined in their cheerful ranks,
And now we place our signatures
Beneath this vote of thanks."

At Plymouth, where the ship arrived on Wednesday morning, at five o'clock, representatives of the Verein deutscher Ingenieure came aboard to greet the Society. These were E. Kroebel, Dr. I. Milsen, Prof. G. Frasch, and Prof. Conrad Matschoss. The Hamburg-American Line was also represented by Aug. Joseph, H. Schulte-Pelkum and Carl H. Lody.

A complete account of the meeting abroad will appear in subsequent issues.

KELVIN MEMORIAL WINDOW

The Kelvin Memorial Window which has been erected in Westminster Abbey in memory of Lord Kelvin, the designer of the first successful apparatus for ocean cables, will be unveiled on July 15 with a suitable dedication ceremony. The Society which is one of the eighteen engineering organizations here and abroad participating in this memorial will be represented at the unveiling, some of the members in attendance at the German meeting going to England for the purpose.

The general design of the window is of the same character as that of the Baker Window near which it has been placed, erected several years ago.

APPLICATIONS FOR ELECTION

The Membership Committee have received applications from the following candidates. Any member objecting to the election of any of these candidates should inform the Secretary before August 15, 1913:

ANDERSON, ROSS, Bridgeville, Pa.
BECKWITH, HENRY C., Portland, Ore.
BLACK, GEORGE, Troy, N. Y.
BRINLEY, CHARLES E., Philadelphia, Pa.
BROCK, CLARENCE A., Worcester, Mass.
BRYCE, RICHARD M., Easton, Pa.
BUCKINGHAM, EARLE, Hartford, Conn.
BUCKWALTER, TRACY V., Altoona, Pa.
BURLING, HERBERT S., Summit, N. J.
BUSHNELL, LEONARD T., Seattle, Wash.
DARGERT, HENRY D., Salamanca, N. Y.
DUFTY, ARTHUR, Lafayette, Ind.
ELLIS, HENRY G., Ansonia, Conn.
FITZSIMMONS, JAMES C., San Francisco, Cal.
FRINK, GERALD, Seattle, Wash.
GERSONI, LOUIS J., Brooklyn, N. Y.
GIVAN, ALBERT, Sacramento, Cal.
HAINES, PHILIP G., Rochester, N. Y.
HEIMANN, LEOPOLD, Elizabeth, N. J.
HIBBARD, ROBERT L., Leetsdale, Pa.
HOWIE, HOWARD BENSON, Chattanooga, Tenn.
KEUFFEL, CARL W., Hoboken, N. J.
LONG, L. GUY, Indianapolis, Ind.
LOVELAND, GEORGE E., Palmerton, Pa.
MCARDELL, WESLEY E., Brooklyn, N. Y.
MITCHELL, GUY K., Baltimore, Md.
PALMER, RAFAEL M., San Juan, Porto Rico
PARKER, DANIEL HOLMES, Windsor, Vt.
PETERS, R. F., San Antonio, Texas
PORTER, FINLEY R., Trenton, N. J.
RALLI, VICTOR P., New York
RUBLE, JOSEPH S., Cleveland, Ohio
SCHUCHART, THEODORE, Mülheim, Germany
SELLEW, WILLIAM H., Detroit, Mich.
SOUTH, FURMAN, JR., Edgeworth, Pa.
SPONSEL, JOHN G., Urbana, Ill.
STRATTON, SAMUEL W., Washington, D. C.
TABER, WM. B., Radnor, Pa.
WARING, CHAS. A., Dayton, Ohio
WELCHANS, BERTRAM G., Hamilton, Canada
WELD, ALFRED O., Winchester, Mass.
WRIGHT, STANLEY, St. Louis, Mo.

PROMOTION FROM ASSOCIATE

NELSON, JAMES W., Brooklyn, N. Y.
WILSON, LESTER G., Norfolk, Va.

PROMOTION FROM JUNIORS

COES, HAROLD V., Boston, Mass.
MONTGOMERY, STAFFORD, Riverside, Ill.
SWARTWOUT, EVERETT W., Chicago, Ill.

SUMMARY

New applications	42
Promotion from Associate	2
Promotion from Junior	3
Total	47

CHRONOLOGY OF AVIATION

The Society has received from Mr. Hudson Maxim and Mr. William J. Hammer, a limited number of their very complete Chronology of Aviation, originally prepared for the World's Almanac of 1911, and recently issued in pamphlet form. The data embrace the essential facts relating to aerial progress, giving, in addition to a short historical resumé, tables showing altitude and quick starting and slow speed records, and passenger

carrying records, with accounts of English channel and other over-water flights, cross-country flights, and notable distance and duration flights. There are also statistics relating to accidents and data relative to spherical and dirigible balloons or airships, etc. Of no small interest are the tables giving the most important work of the Wright brothers.

Any member of the Society who is interested in this subject and who would be glad to secure a copy of this interesting brochure, may do so by applying to the Secretary.

EFFICIENCY OF ROPE DRIVING AS A MEANS OF POWER TRANSMISSION

By E. H. Ahara

ABSTRACT OF PAPER

This paper deals with a series of tests on transmission of power by rope drives under various conditions. The efficiency is measured under full, three-quarters, one-half and one-quarter loads. One inch best manila rope was used. The test covers drives of from one to eight ropes, with centers from 25 to 150 ft., on both American and English systems.

Tests also covered open, or straight drives, as well as indirect, or up and over drives.

The efficiencies as shown indicate a greater efficiency in the American than the English system. Medium speeds, though showing less capacity, show a greater efficiency than high speeds.

Accurately turned sheaves show a decided gain over ones that vary in pitch diameter; and direct drives are always preferable to the indirect ones.

The efficiency of rope driving does not materially vary over a wide range of different working tensions in the rope.

EFFICIENCY OF ROPE DRIVING AS A MEANS OF POWER TRANSMISSION

By E. H. Ahara, Mishawaka, Ind.

Member of the Society

Of the several types of mechanical power transmission including belting, gearing, rope driving, etc., the question of efficiency of the last has perhaps received the least attention and, outside of general treatment, very little engineering literature, considering the importance of the subject, is obtainable. While transmission by rope systems of various kinds is a very old method of transmitting power from one shaft to another, being used, according to one authority to a limited extent by C. F. Hern, of Logleback on the Rhine, Germany, as early as 1852, the difficulty of obtaining accurate measurements of the power consumed by the rope itself has prevented its efficiency being easily ascertained in practical work. Because of the ease with which electrical measurements can be taken by means of direct reading instruments, which enabled power consumption to be measured so much more readily than by any other means, electrical power itself has been given much more attention than other types of power service.

2 Owing to there being no way of determining the losses in transmission in regular working rope drive installations, the efficiency can be ascertained only by laboratory, or test outfits, and these, considering the diversity of types and methods, the large number of variables involved, as well as the vast difference in working conditions and capacities, are necessarily elaborate and the expense of such tests has tended to limit the knowledge obtainable in this way. The present tests were undertaken with the object of obtaining, in a practical way, some definite figures on a few of the several variables in rope-driving practice, and

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it is believed that the plan is broad enough in its scope to give reliable data whereby the efficiency of most drives may be very closely approximated.

3 The importance of the tests may be estimated from the conclusions that are deducible from the data obtained. They seem to show that the efficiency in rope driving is considerably greater at the lower speeds than at the higher ones, the dropping off being especially noticeable above 4500 ft. per min. of rope speed. They also show that the efficiency of a rope drive is not materially affected by distances between centers up to 150 ft., that the drop of efficiency at 50 per cent load is comparatively small over that of full load, and that if proper care is exercised to have all grooves perfect in pitch diameter many as well as few ropes can be run on a drive with good efficiency. With the American system, increasing the slack rope tension up to 360 lb. in a 1-in. rope does not appear to decrease its efficiency, but rather to increase it if power is used in conformity with this tension; but only such tension should be used as is necessary to drive the load needed. For the rope tested the American system has very much more capacity than the English system, and has also a higher percentage of efficiency. In general it would appear that, where there is a considerable power to be transmitted, the properly worked out rope drive gives a most efficient and economical method, and where conditions are favorable to its installation no other known method of transmission will so well conserve power losses.

4 There are two general systems of rope driving in common use: (*a*) the English system, the oldest, which uses a series of separate ropes, each spliced up into an endless band and occupying a separate groove on the face of each of the sheave wheels: and (*b*) the American system, the more modern, patented in the United States by W. H. Dodge, June 23, 1885, which uses one continuous rope wound about the driver and driven sheaves with a loop taken over a weighted tightener wheel, that keeps a definite tension continually in the ropes. Wire ropes or cables are sometimes used, but so rarely that no attempt was made to study their efficiency. Manila fiber ropes, which are used almost entirely in rope transmission work, were used exclusively in these tests.

5 These two general systems were tested in open drives of from one to eight ropes each under speeds of rope travel from 2500

ft. per min. to 5500 ft. per min., on center distances varying from 25 ft. to 150 ft. and with varying loads. Difficulty was found in handling the English system on 125 ft. and 150 ft. centers on account of the slack rope, which was the upper one, sagging down through the tight ropes and rubbing on the ground. This limited the work on the English system to 112 ft. centers as the maximum. Other than this limit, and the fact of varying tensions on the 100 ft. centers, the English test followed the same schedule also.

6 Both English and American systems were also tested on what is termed "up and over" drives, i. e., with four idlers, on approximately 100 ft. centers with the same approximate speeds as above, and with from one to eight ropes. There were also tests taken on the American system to determine the efficiency and capacity under different strains in the pulling rope. In all about 700 tests were taken with upwards of 7000 readings. The tests were all taken in the open air, at the plant of the Dodge Manufacturing Company, Mishawaka, Indiana, and extended over a period of five months of continuous work, ten hours a day, from August to December 1912. But few days were lost during the entire series of tests and these only on account of rainy weather.

7 The general method of conducting the test embraced the use of a 250-h.p. Westinghouse direct-current motor driving through an auxiliary rope drive to a jack shaft on which was mounted the 60-in. test driver; the driven shaft was fitted in bearings on a movable tower, and on the driven shaft was mounted the receiving sheave, of the same diameter as the driving sheave, and also a prony-brake wheel. Fig. 1 is a view of the equipment in operation with sheaves at 50 ft. centers and carrying seven ropes at 4500 ft. per min. on the American open-drive system, at a time when 155 h.p. was being transmitted. The test outfit included also a Weston standard volt meter, a Westinghouse milli-volt meter with 750 ampere shunt, a Schaeffer and Budenberg hand tachometer with three scales, two hand revolution counters, and a standard Fairbanks platform scale.

8 In taking a test one observer recorded the electrical consumption, the polarity being reversed and the average voltage taken; another applied the brake and kept the load constant; a third recorded the revolutions of the driven shaft; a fourth recorded the revolutions of the driver, and still another observed

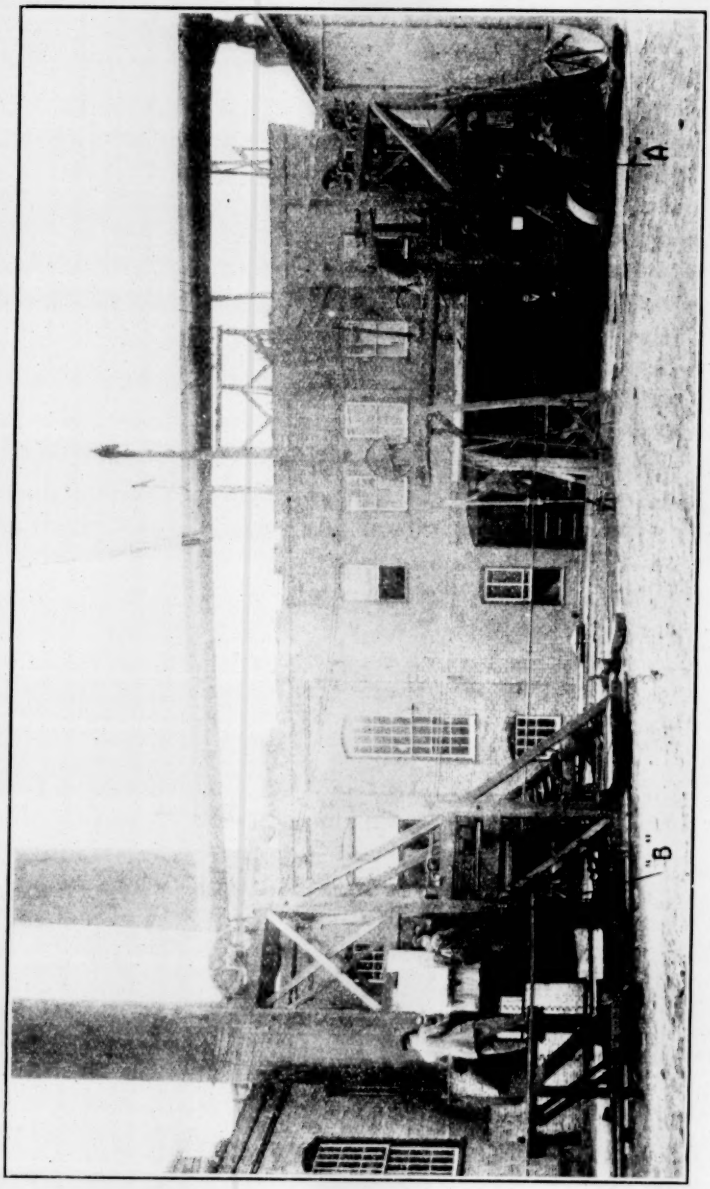


FIG. 1 ARRANGEMENT OF APPARATUS, AMERICAN OPEN DRIVE, 50 FT. ON CENTERS, SEVEN ROPES, 4500 FT. PER MIN., 155 H.P.

the sag of the rope in the center of the span. By means of electrical signals all observations were started at the same instant to avoid the effect of continual slight variations; if there arose any reason for doubt of a test being correct it was repeated. The ammeter used was compared weekly with a carefully calibrated test instrument and found to maintain its accuracy during the test. The volt meter was frequently checked by another

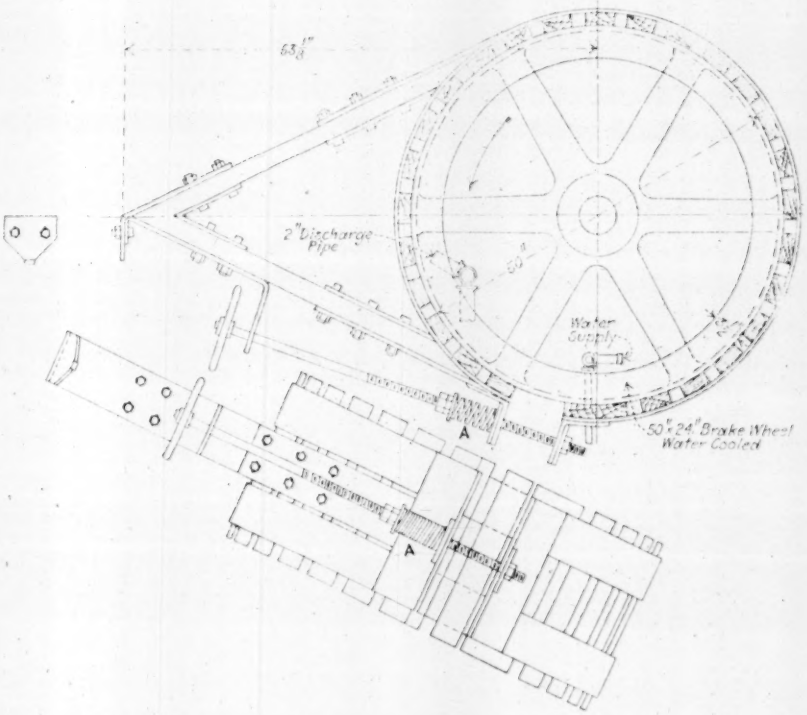


FIG. 2 DETAILS OF PRONY BRAKE USED IN TESTS

constantly in circuit on the main switchboard. The start was made by means of a water rheostat which was cut out by a knife switch when the motor reached full speed.

9 Owing to the large variations needed in loading on the prony brake the load measurements were taken directly on a platform scale, careful corrections being made for the weight of the prony-brake lever; also the latter was made of such length that $\frac{\text{Wt.} \times \text{r.p.m.}}{1000} = \text{h.p.}$ The brake wheel was flanged so as to

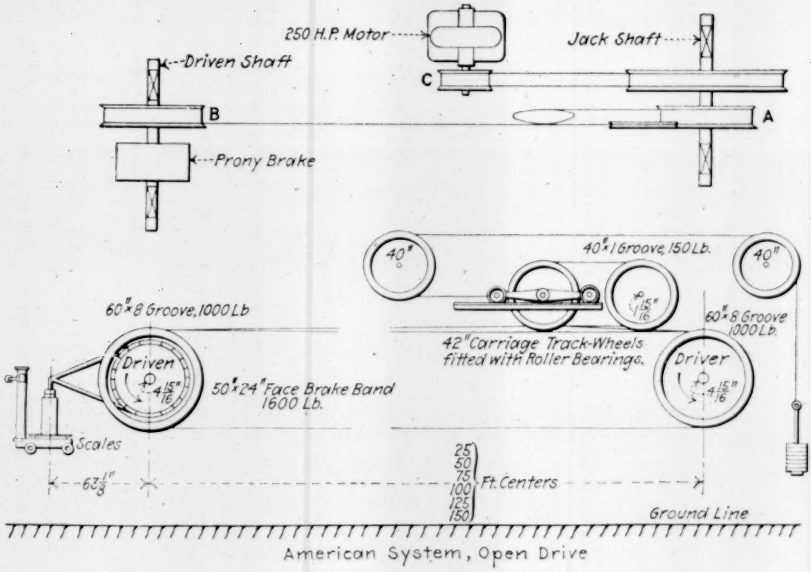


FIG. 3 GENERAL PLAN OF AMERICAN OPEN DRIVE SYSTEM

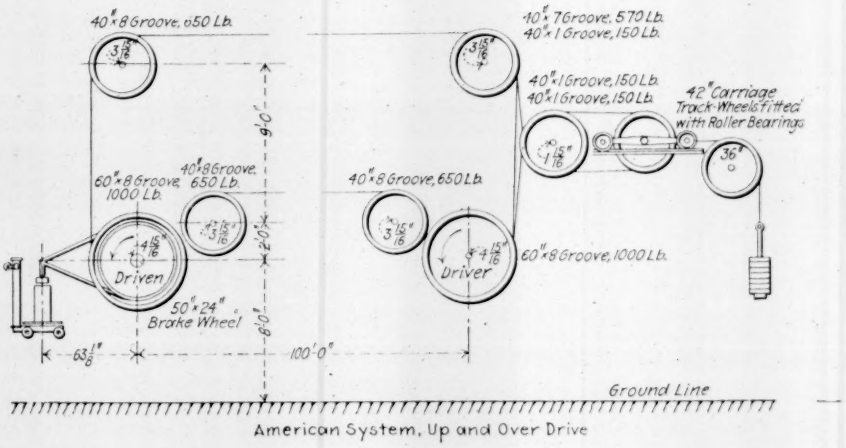
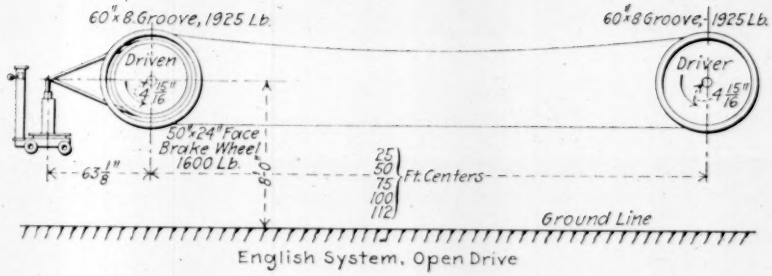
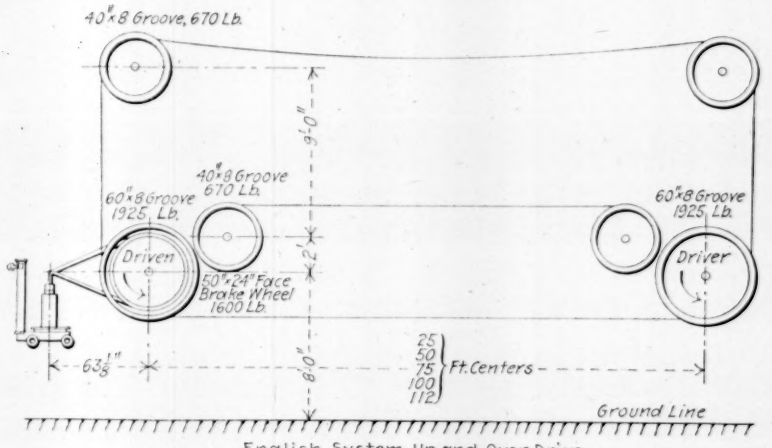

40" × 8 Groove, 650 Lb.
40" × 7 Groove, 570 Lb.
40" × 1 Groove, 150 Lb.
40" × 1 Groove, 150 Lb.
40" × 1 Groove, 150 Lb.
42" Carriage Track-Wheels fitted with Roller Bearings
60" × 8 Groove 1000 Lb.
40" × 8 Groove 650 Lb.
40" × 8 Groove, 650 Lb.
Driven
Driver
60" × 8 Groove, 1000 Lb.
50" × 24" Brake Wheel
63 1/8"
100'0"
Ground Line
American System, Up and Over Drive

FIG. 4 GENERAL PLAN OF AMERICAN "UP AND OVER" DRIVE SYSTEM

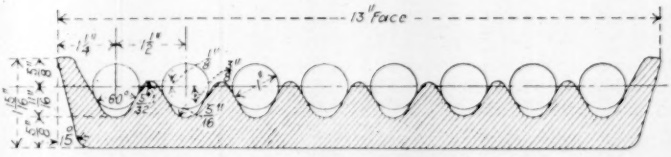


English System, Open Drive

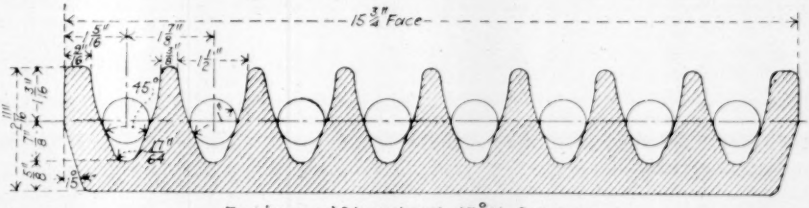


English System, Up and Over Drive

FIG. 5 GENERAL PLAN OF ENGLISH OPEN DRIVE AND "UP AND OVER" DRIVE SYSTEMS



American Standard 60° V-Grooves



Engineers' Standard 45° V-Grooves

FIG. 6 DETAILS OF AMERICAN AND ENGLISH TYPES OF GROOVES USED ON DRIVER AND DRIVEN WHEELS

hold a considerable quantity of water on the inside of the rim while running, and cooling water was constantly supplied from a city water main, through a 1-in. pipe, and carried away through a 2-in. pipe; the quantity used being varied by means of a valve to suit conditions. The surface of the brake wheel was well lubricated, and having a brake band faced with cross bars of hard maple, no particular difficulty was experienced in working the brake up to 250 h.p. A spring used in the brake pressure connection at *A*, Fig. 2, prevented sudden seizing of the brake band and aided in keeping the scale load uniform. By using a proper capacity of spring, the tension of which could be varied by the screw adjustment, very good results were obtained.

10 The general plan of the American open drive is shown in Fig. 3, of the American "up and over" drive in Fig. 4, and the English open and "up and over" drives in Fig. 5. In Fig. 6 are given the details of the American and English types of grooves used on driver and driven wheels. All idler or carrier wheels used had U-shaped grooves into which the rope bottomed without side friction. The weights of all wheels, as well as dimensions, are given to afford some idea of the inertia. All bearings on all shafts were ring oiling bearings except those on the carriage axle which were ordinary grease bearings.

11 The different speeds were obtained by changing the sheaves on the motor and jack shafts and for convenience sheaves were used in pairs that gave respectively 2500 ft., 3500 ft., 4500 ft., and 5500 ft. of rope travel per minute. In order to eliminate the factor of friction of the motor itself and the jack shaft, with intervening drive, every test was started by first applying the prony brake to the jack shaft, and taking readings to determine the friction load of the motor and jack shaft under the various loads and with the various speeds of jack shaft as were to be used in the rope-drive tests later. The prony brake was then removed to the receiving shaft and the test proper carried through. Again, at the close of these observations, the brake was applied to the jack shaft and the friction readings again taken for comparison with the friction readings taken at the beginning of the test. These data were tabulated and charted, a sample of the tabulations for one set of conditions, namely, the American system, open-drive, operated with six ropes

at the 2500 ft. speed, being shown in Table 1; this gave a measured output of 945 lb. on the brake at 156 r.p.m., or 147.4 h.p., the electrical readings being 262 volts and 101.7 amperes, which equals 133,227 watts. Then by applying a load such as to cause a corresponding electrical reading with the brake applied to the jack shaft, the input to the drive was found to be 153.4 h.p. Comparisons of input horsepower as given in column 13, Table 1, and delivered horsepower as given in column 9 gives the efficiency as recorded in column 14, which is 96.1 per cent in this case.

12 The efficiency as above given includes the losses in the rope itself, the friction in the bearings on the driven shaft, and the losses due to the inertia of the driven wheel and the prony-brake wheel, and, also, in the American system the friction of the tension equipment. All tests were made to include the friction of the receiving shaft and bearings as it was thought this would more nearly approximate working conditions and make the data obtained of more general application in ordinary comparisons. All bearings used were of the ring oiling babbitted type, and the ropes were all 1-in. manila rope of best quality, carefully treated with a rope dressing to prevent the entrance of moisture and to keep the surface in as nearly uniform condition as possible. It was found during the test that this was of great importance as very slight changes in the rope surface immediately affected its capacity and efficiency.

13 The same rope was used throughout the American open drive test, the tests being run in such order that the rope was shortened at each succeeding test, and thus there was never more than one splice in the rope, thereby reducing any inaccuracy from lack of uniformity in the splice of the rope to the least possible point. This same care was observed in all of the tests, no rope being used with more than the necessary single splice, and these were in every case carefully made. Frequent photographs were taken showing the positions of the ropes under varying conditions, speeds and centers, which gave a very good idea of the test as it proceeded.

14 Fig. 7 gives the results obtained in the American open drive test for six ropes 50 ft. centers with efficiency plotted against speed; Fig. 8, the results of efficiency relative to varying centers, seven ropes at the 4500 ft. speed, and Fig. 9, efficiency relative to number of ropes for 50 ft. centers at the 4500 ft. speed.

TABLE 1 METHOD OF TABULATION OF DATA

TEST ON ROPE DRIVE EFFICIENCY

AMERICAN SYSTEM—OPEN DRIVE DATE. 9-30-12

No. of Ropes	Speed of Ropes	Wt. on Take-up	Sheave Centers	Sag of Rope		Prony Brake			Electrical Reading			Net H.P. Consumption Compared with Prony Brake	Efficiency	Remarks
				Tight	Loose	Weight	Revolutions	H.P.	Volts	Amperes	Watts			
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	Col. 13	Col. 14	Col. 15
6	A	360 lb.	50′-0″	3″	7″	945	156	147.9	262	101.7	133227	153.4	96.1	

15 It will be seen that a lower efficiency is shown on the lower number of ropes. This is undoubtedly caused by the fact that the eight-grooved wheel made for testing eight ropes was used for all the lesser number of ropes to avoid the expense of making additional wheels with a suitable number of grooves for each drive. This together with the weight of the prony brake increased the proportional friction on the smaller loads, and

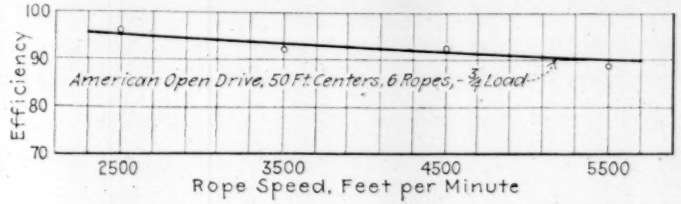


FIG. 7 RESULTS OBTAINED IN AMERICAN OPEN DRIVE TEST WITH EFFICIENCY PLOTTED AGAINST SPEED

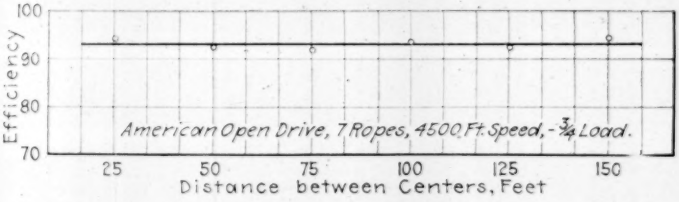


FIG. 8 CURVE SHOWING EFFICIENCY RELATIVE TO VARYING CENTERS

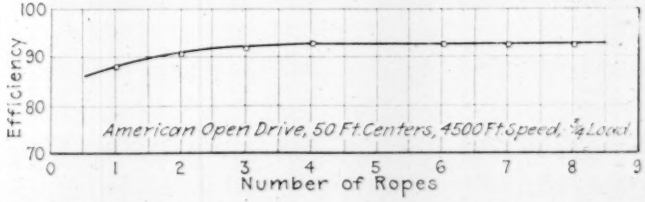


FIG. 9 CURVE SHOWING EFFICIENCY RELATIVE TO NUMBER OF ROPES

is, therefore, a larger percentage of the total load in the drive of few ropes. With the friction of driven shaft eliminated, limiting the losses to those in the rope alone, it is believed the efficiency in a single rope would be as great if not greater than any multiple thereof.

16 All readings were taken at four different capacities. The rope was brought up to speed, and the brake gradually applied

until the observation of r.p.m. on the driving and driven shafts showed a slippage, when the brake pressure was released a trifle and the observation called "full load" taken. By changing the brake, 75 per cent, 50 per cent and 25 per cent of this load was also observed. Fig. 10, which is a good representative case, gives the comparisons of efficiency with these

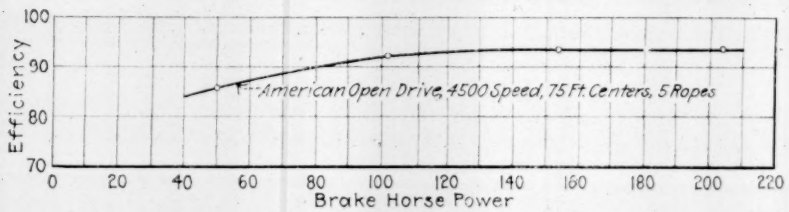


FIG. 10 CURVE SHOWING COMPARISON OF EFFICIENCY WITH VARIOUS LOADS

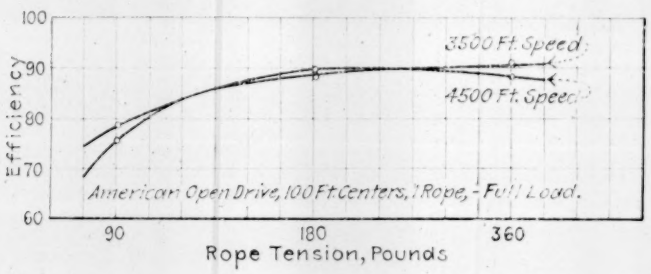


FIG. 11 CURVE SHOWING EFFICIENCY PLOTTED AGAINST VARIOUS ROPE TENSIONS

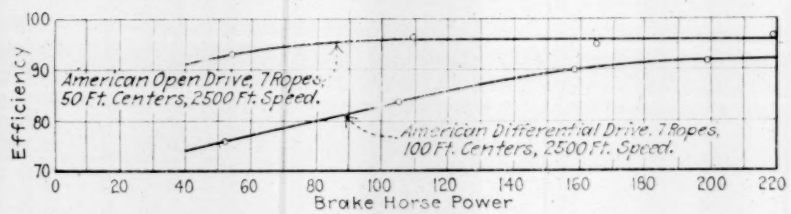


FIG. 12 CURVE SHOWING COMPARISON BETWEEN EXACT AND DIFFERENTIAL DRIVES

various loads. Owing to the limited capacity of the motor (250 h.p.) the slippage point was not reached on many of the tests involving the higher speeds and number of ropes. In these cases the high record was taken at the motor capacity and so recorded.

17 In all of the above tests the tension in the slack side of

the rope was kept as uniform as possible at 180 lb. by means of weighting the tension carriage properly. In order to ascertain what tension would give the greatest degree of efficiency, irrespective of life of rope or wearing qualities, a test was made with the slack rope under varying tensions, the results of which are given in Fig. 11. This is shown on one rope because the capacity of the single rope was, under the heavy tension, as great as that of the motor, so no proper comparison could be obtained on more than one rope.

18 One of the greatest troubles in rope driving, when installed by inexperienced engineers, has been the lack of uniformity in pitch of the grooves where many ropes were used. This differential in the grooves compels slippage of the ropes which not only causes loss of power, but also rapidly depreciates the rope, and often causes the rope to flop around badly. To test the loss of efficiency in this case two wheels 60 in. in diameter, of eight grooves each, were made up exactly alike so far as could be, and after most careful measurements the grooves on either wheel were found not to differ more than 1/64 in. in circumference from any other on the same sheave, and a test made. The driver was then removed, and the pitch diameter of each groove made approximately 1/32 in. less than the preceding groove so the eighth groove was ¼ in. less in diameter than the first one. Again it was placed on the driving shaft and a duplicate set of tests made, the general tendencies of which are given in Fig. 12. In this test as the first groove was ¼ in. larger in pitch diameter than the eighth groove, with the sheave revolving at 160 r.p.m., there would necessarily be a slippage in an inelastic band of over ten feet per minute.

19 The photographs taken of this differential drive, shown in Figs. 13 to 16, in which the horsepower transmitted is 52 h.p., 110 h.p., 165 h.p., and 220 h.p., are quite illuminating, as they show plainly the sag of the various ropes under this condition, and how under heavy load they stretch and slip on the grooves of the sheave. The elasticity of the rope in this case undoubtedly lends itself to aid efficient operation.

20 The "up and over" American drive, so called because of its course upward from a driver, over idler wheels, then horizontally for a distance and down over idler wheels to the driven wheel, was tested because it is typical of all but direct drives,

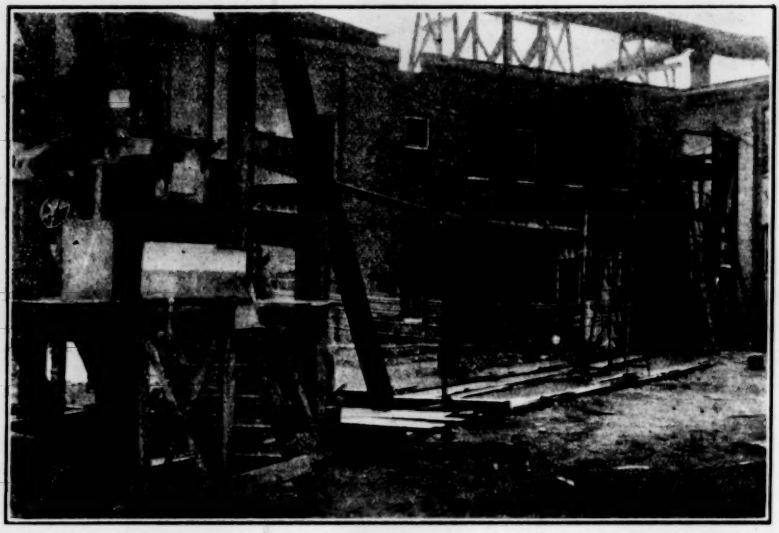


FIG. 13 AMERICAN DIFFERENTIAL DRIVE, 100 FT. ON CENTERS, SIX ROPES, 2500 FT. PER MIN., 55 H.P.

FIG. 14 AMERICAN DIFFERENTIAL DRIVE, 100 FT. ON CENTERS, SIX ROPES, 2500 FT. PER MIN., 110 H.P.

FIG. 15 AMERICAN DIFFERENTIAL DRIVE, 100 FT. ON CENTERS, SIX ROPES, 2500 FT. PER MIN., 165 H.P.

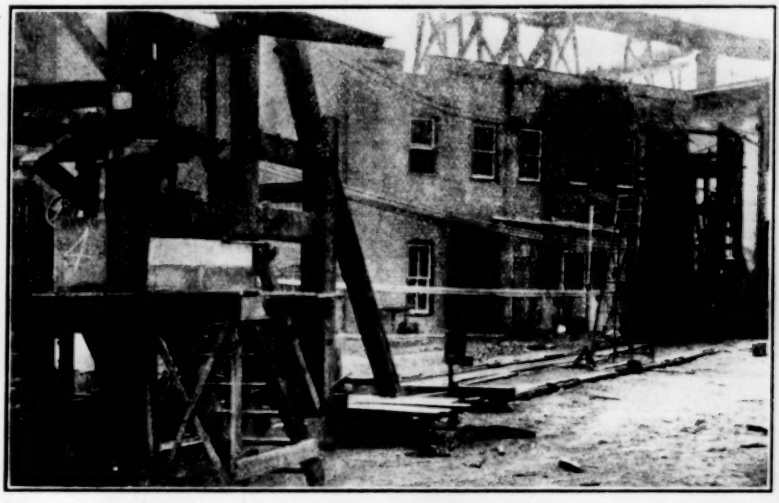


FIG. 16 AMERICAN DIFFERENTIAL DRIVE, 100 FT. ON CENTERS, SIX ROPES, 2500 FT. PER MIN., 220 H.P.

i. e., straight from driver to driven, and the difference in efficiency between this type and the open drive, as shown in Fig. 17, will serve as a basis of comparison where but two additional right-angle turns are introduced requiring four additional idlers. This test was run on approximately 100 ft. centers with a new rope, the same rope being afterwards used in the testing of the various English drives.

21 In testing the English drives, that proper comparisons

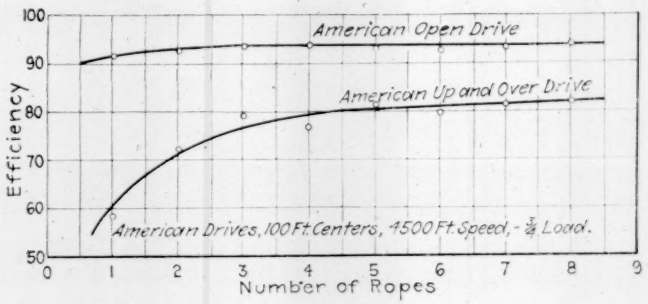


FIG. 17 CURVES SHOWING DIFFERENCE IN EFFICIENCY BETWEEN AMERICAN OPEN DRIVE AND AMERICAN "UP AND OVER" DRIVE WITH VARYING NUMBERS OF ROPES

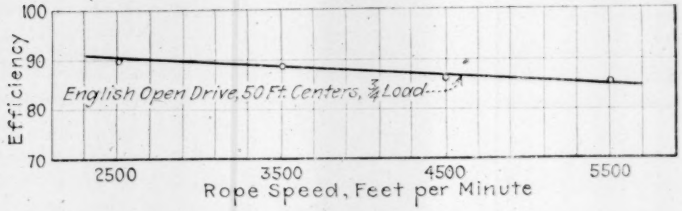


FIG. 18 CURVE SHOWING EFFICIENCIES AT DIFFERENT SPEEDS WITH ENGLISH OPEN DRIVE

might be made, the ropes were all cut to the same measured length, and the splices carefully made, so that all ropes might be equally tight when applied to the sheaves. The movable tower was then carefully moved back, the rope being run slowly meanwhile until the sag in the rope was approximately the same as in the American drive of the same center distance in which the slack rope was under a tension of 180 lb. This is undoubtedly a higher tension than is used in general practice on the English drive system with this size of rope, and the capacities

and efficiencies shown are perhaps higher than are ordinarily attained in common practice. Fig. 18 gives the efficiencies, when compared by speeds, of the English open drive. This shows a

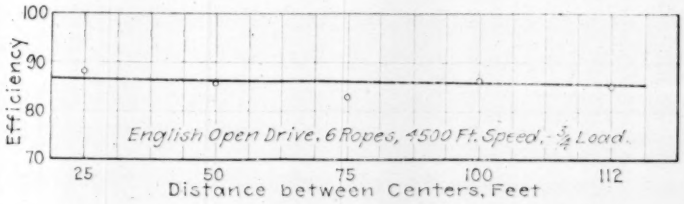


FIG. 19 CURVE SHOWING EFFICIENCIES OF ENGLISH OPEN DRIVE WITH VARYING CENTERS

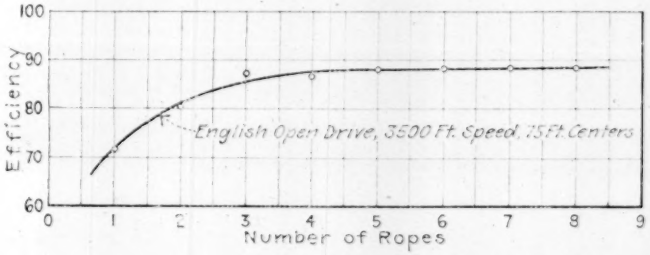


FIG. 20 CURVE SHOWING EFFICIENCY OF ENGLISH OPEN DRIVE RELATIVE TO NUMBER OF ROPES

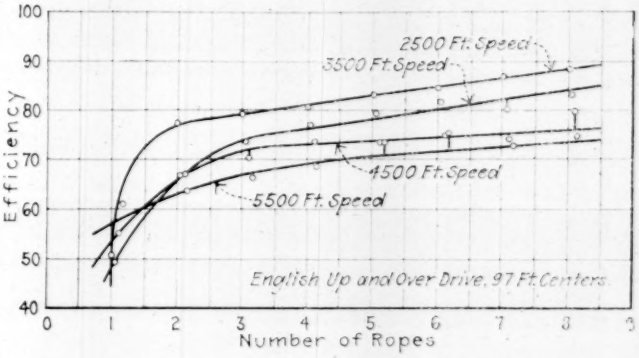


FIG. 21 CURVE SHOWING EFFICIENCIES OF "UP AND OVER" ENGLISH DRIVE WITH DIFFERENT NUMBERS OF ROPES AT FOUR DIFFERENT SPEEDS

marked decrease in efficiency as the speed of the rope increases, falling as low as 84.5 per cent at 5500 ft. rope speed.

22 The general tendency in all tests made, both English and American, was corroborative of this tendency toward decrease

in efficiency as the speed of the rope increases. There was, however, a lack of smoothness to many of the curves owing, it was thought, to variations in rope tension, and perhaps slight changes in the surface of the rope due to climatic changes. This was very much more noticeable on the English than on the American systems, the irregularity of the curve on the former

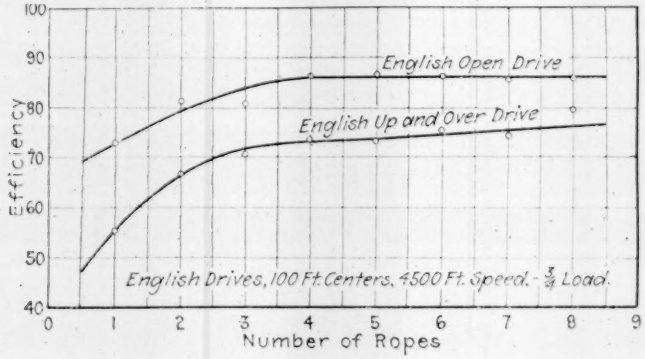

English Open Drive
English Up and Over Drive
English Drives, 100 Ft. Centers, 4500 Ft. Speed, - ¾ Load.
Efficiency
Number of Ropes

FIG. 22 COMPARISON OF EFFICIENCY BETWEEN ENGLISH OPEN DRIVE AND "UP AND OVER" DRIVE

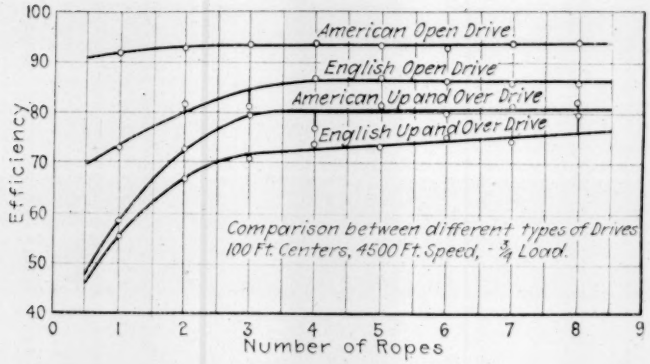

American Open Drive
English Open Drive
American Up and Over Drive
English Up and Over Drive
Comparison between different types of Drives
100 Ft. Centers, 4500 Ft. Speed, - ¾ Load.
Efficiency
Number of Ropes

FIG. 23 COMPARISON OF EFFICIENCIES OF FOUR GENERAL PLANS OF ROPE DRIVING UNDER UNIFORM CONDITIONS

being affected by the fact that a greater load was sometimes attained on a certain speed than could later be reached on the next higher speed. The results relative to varying centers with six ropes on the 4500 ft. speed are given in Fig. 19, and Fig. 20 gives the results relative to number of ropes with 75 ft. centers and the 3500 ft. speed.

23 It will be seen by reference to Fig. 19 that the efficiency

of the English drive, within the limit of distances tested, remains practically constant irrespective of center distance; while with reference to number of ropes, it increases as does the American for the first few ropes, and then remains practically constant through the additional ones. Fig. 21 gives the "up and over" English drive relative to number of ropes plotted on the four different speeds. This shows very clearly the greater efficiencies of the slower speeds. The center distance on all the "up and over" drive tests was approximately 100 ft. that direct comparisons with the open drives on the corresponding centers might be made.

24 In order to test the effect of tension on the English system a comparison was made by moving the receiving tower forward 1¼ ft. after making a series of tests, and then making another corresponding series. When sheaves with proper English pinch grooves, as shown in Fig. 6, were used there was no appreciable difference either in power transmitted or in efficiency. Greater variations than 1¼ ft. in center distances could not be satisfactorily tried because of the slack ropes dragging on the ground.

25 A comparison of efficiency between the English open drive and the English "up and over" drive is given in Fig. 22. In Fig. 23 is given a representative comparison of the efficiencies of the four general plans of rope driving on a center distance of 100 ft. and a rope speed of 4500 ft. per min.

26 A new rope was used on the American open drive, another new one being started with the American "up and over," which latter was also used on both the English drives. The time of introducing the new rope is mentioned because it was found that a new rope had very much less capacity, owing to its low coefficient of friction, than the same one had after it had run a short time in work, and having less capacity it would usually have less efficiency also. The stiffness of the rope when it was new also seemed to add friction to the drive owing to the bending action in passing around the sheaves, which on the test were only 60 in. in diameter. With larger main drive wheels, where the rope is not bent to so small a radius, the efficiency would undoubtedly be slightly increased over the results here shown.

27 The capacities of rope drives are affected by so many variables that no particular attempt is here made to state capacity

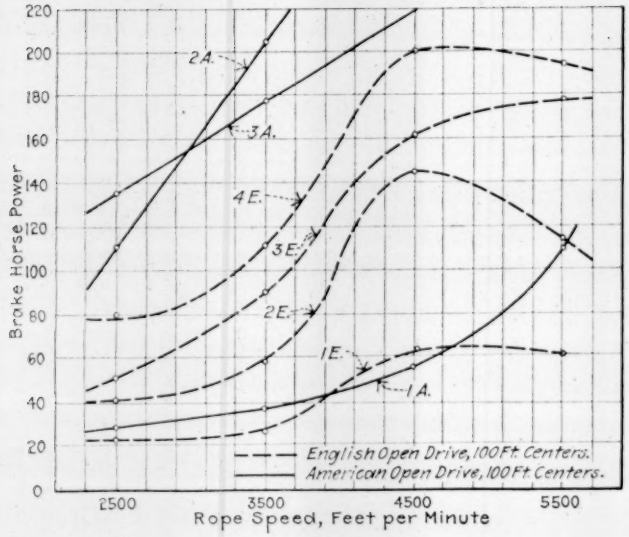


FIG. 24 CURVES SHOWING LIMITS OF CAPACITY OF TWO FORMS OF OPEN DRIVE AT FOUR DIFFERENT SPEEDS

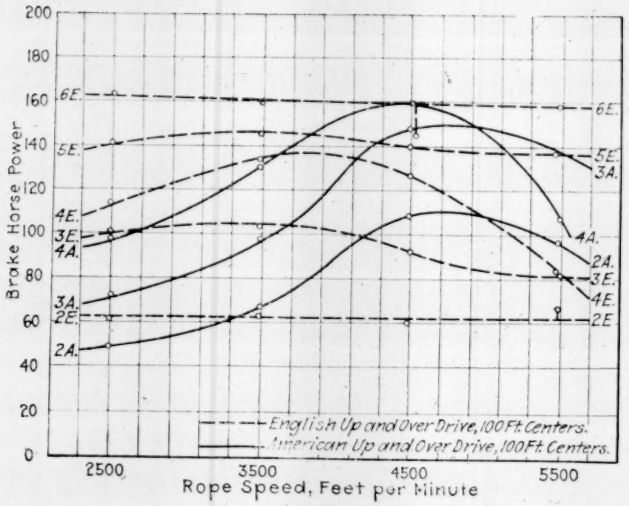


FIG. 25 CURVES SHOWING LIMITS OF CAPACITY OF TWO FORMS OF "UP AND OVER" DRIVE AT FOUR DIFFERENT SPEEDS

other than in general figures, obtained as indicated in the early part of this paper, and used merely to have a uniform method of taking the tests. Fig. 24, however, gives a general idea of some limiting capacities obtained in the open drives, and Fig. 25 some of those obtained in the "up and over" drives. These limiting capacities shown are in no sense to be considered as available working capacities, but merely as limits reached in driving capacities, the general tendency of the whole series being used to form a decision, rather than any one curve, the practical working capacity being much lower than the limits shown. It is to be regretted that the power available was not great enough to get the larger capacities as so few points were obtainable on the American open system. Even at the low speed of 2500 ft. four ropes could not be made to slip with the 250 h.p. available.

28 The irregularities of these limiting horsepower capacities are caused by many variables some of which are weather, surface conditions of rope, condition of rope wheel grooves, etc. In connection with the groove in the wheel it was found that if a rope began to slip in a groove and warmed it up slightly the coefficient of friction seemed to decrease very rapidly, and if a limiting test were made under these conditions it was invariably much lower than if it were taken just before the rope started to slip. As each test had to be taken in its scheduled order some of those shown were taken at intervals of several weeks.

29 As the limiting capacities of the English drive are very much lower than the American, it is thought the efficiency is likewise affected, the friction in the former case being a much larger proportion of the power delivered. And again, the English system in order to get driving power in the rope, pinches it in the narrow groove requiring considerable force again to withdraw it. This effort being exerted many times a minute uses up considerable power. The American system, on the contrary, uses a 60-deg. groove into which the rope lies freely and withdraws without effort.

30 In conclusion, much credit is due Mr. W. H. Tupper who gave important aid in the electrical part of the work, and to Mr. E. M. Carver who personally superintended the test work and carried out the major part of the computations.

THE MYRIAWATT AS A UNIT OF POWER

The proposal of the myriawatt, as a new unit of power to replace the boiler-horsepower, in a paper by H. G. Stott and Haylett O'Neill before the annual convention of the American Institute of Electrical Engineers in June 1912, was referred to in The Journal for February 1913, as well as the Society's special committee on the myriawatt in joint meeting with the Standards Committee of the American Institute of Electrical Engineers on December 23, 1912, favoring its adoption. The action incited discussion from William Kent and George H. Barrus, which was printed in THE JOURNAL for May 1913, and in order to bring the question before the Society as a body, an opportunity for further discussion was offered at the Spring Meeting at Baltimore, Md., May 20 to 23, 1913. The discussion offered is presented below, notable among which is a statement by Haylett O'Neill, one of the authors of the original paper proposing the unit.

DISCUSSION

Further discussion was contributed by Geo. H. Barrus, vice-chairman of the Committee on Power Tests, in the form of extracts from letters received by him from members of his committee, as follows:

E. F. Miller says

> I can see absolutely no reason why we should adopt the myriawatt. I think it would be a mistake for our committee to recommend that this unit be used.

L. P. Breckenridge says

> It would seem to me unfortunate if we should adopt a myriawatt which would do away with our old friend the horsepower. I am in accord with your presentation.

Arthur West says

> I am decidedly opposed to the exclusive use of myriawatt as a measure of boiler capacity, for the reason that boilers are not employed exclusively as a means for producing electricity. When boilers are used for other purposes, an entirely unnecessary and perhaps confusing complication is introduced.

CARL SCHWARTZ. Mr. Kent has made it quite clear that he disapproves of the report of the committee. In The Journal

for May he states, "The gallon, a useless unit, is slowly being replaced by the cubic foot, etc." We also find, "The horsepower is here to stay and we can no more eliminate it than we can eliminate the gallon, etc." The discovery of a method is announced of bringing both electrical and thermal units into a simple relation with the English system, so Mr. Kent must have felt that there is a clear demand for just such a thing as the myriawatt, still he does not hesitate to propose a method he thinks has undeniable merits but which it is seen at a glance can hardly be made more complicated.

Mr. Kent objects to the introduction of the new term myriawatt which, in fact, is an old unit with a new self-explanatory term and a new application, but recommends a "vim" system for which he advocates not less than six new terms as follows: vim, kilovim, volt-vamp, therm, vamp and vohm. In addition to this, the centigrade thermometer scale is stated to be defective in having its zero point at the freezing point of water and this serious disadvantage is proposed to be eliminated by a new thermometer scale. Also, the ammeter is not satisfactory for this system and a new graduation is proposed for converting the ammeter into a vampmeter. An instrument for alternating-current measurements is not given. All of the above suggestions are made in the face of the statement that the average man cannot think in a great variety of units.

Mr. Kent also refers to a recent attack on the English system by the Bureau of Standards, to destroy the old definition of a horsepower as 550 ft-lb. per sec. and define it as 746 watts. The horsepower has long been equal to 746 watts and if the old definition of 550 ft-lb. per sec., or 33,000 ft-lb. per min., was eliminated it would reduce the great variety of units against which such strong objection is raised. The myriawatt, however, is more convenient than the watt or kilowatt because it can be reserved for power input measurements.

The earlier mechanical engineers can agree to eliminate the English system for scientific measurements and substitute a system of units based upon standards in use on the European continent and by electrical engineers, the better it will be because it has long been unfortunate that results of tests and calculations made on the basis of different systems are exceedingly difficult to compare.

Mr. Barrus states that the myriawatt is not a new unit and

that it is already international, but asks why the watt or kilowatt should not be used instead. The use of the watt or kilowatt instead of horsepower would be a distinct advantage, still the use of a term strictly applicable to input measurements seems more desirable.

Mr. Barrus' principal objection is apparently sentimental and seems to rest in an opposition to electrical engineers because he states that the output of a steam plant is 12 per cent and he does not want the tail end to control power plants in general. It would be well for Mr. Barrus not to forget that the "tail end" has an efficiency of between 97 and 95 per cent as compared with say 15 per cent of the head end and that the development of the electrical part has been materially assisted by highly efficient methods of measurement and calculation.

It is hoped that a full discussion of the subject will place before the membership clearly all reasons for the use of the myriawatt instead of the boiler-horsepower and similar units like the "evaporation of one pound of water evaporated into dry steam from and at 212 deg. per hour."

The use of the myriawatt, a unit based on the C. G. S. system, will give us one distinct system of units for all parts of the power plant from the coal pile to the bus bars and make all calculations understood internationally. For scientific calculations, the English system is obsolete today and is discarded by scientists, chemists and electrical engineers, and it should be borne in mind that this matter has no bearing on the question of the relative merits and demerits of the metric system as a unit of practical measurement in manufacture.

Henry Hess. A great deal has been written and a great deal has been said which is altogether foreign to the question at issue. About everything that has been said for and against the myriawatt applies with equal force for and against the watt. The watt is, however, not a unit that requires any defense. It has been in existence, adopted and used for many years. The myriawatt is nothing but a convenient collective noun; it means simply so many watts. The myriawatt is a matter of convenience; absolutely no matters of boiler-horsepower, etc., have anything to do with the question. The whole matter boils down to the one simple thing, do you wish to use a single unit which is a multiple of one already in general use and acknowledged by the objectors

to the myriawatt, or do you prefer to continue to express yourself in the smaller unit watt and its present multiple, the kilowatt? I went to Germany a number of years ago to build a plant there and I took with me a great many drawings of machine tools, which were there redimensioned in the metrical system. I happened to have a problem one day that involved one of our American units and turned the calculation over to a draftsman. This problem involved length, area and volume. The result turned in did not work right and was turned back with instructions to let five men calculate independently. All five agreed as to the figures, but only two agreed as to the location of the decimal point. I insisted on the use of American units without any conversion to the metrical system. I obtained four alike and correct, and one wrong, but with wrong figures. The men were simply confused through the large number of ciphers. Reasoning from that experience, anything whatsoever which cuts down the number of ciphers by using larger units will result in clarification and greater certainty through easier mental conception.

Richard H. Rice. At present in testing steam turbines we use on the electrical end certain instruments based on the C. G. S. system, and on the steam end we use an entirely different set based on the fahrenheit-pound-second system. If we adopt the myriawatt we can use instruments on both ends of the apparatus based on the same system, which seems very desirable.

O. P. Hood. The acceptance of the myriawatt is but a part of the main question, are the mechanical engineers ready at this time to step over to the C. G. S. system?

To begin such a change by accepting a substitute for the boiler-horsepower would seem to me a mistake. We ought to face the general problem and step over bodily with all our units or leave the matter alone.

Charles E. Lucke. I am decidedly opposed to the exclusive use of myriawatt as a measure of boiler capacity for the reason that boilers are not used exclusively as a means of producing power for electricity, and further because more confusion than gain will result from such a change.

Haylett O'Neill.[1] The authors are greatly indebted to

[1] Assistant Engineer Interborough Rapid Transit Co., New York.

Messrs. Kent and Barrus for their discussion of the unit, myriawatt, but an analysis of their arguments reveals the fact that neither of them comprehends the real intentions of the authors in proposing this unit.

Mr. Kent attacks it because it is new, while Mr. Barrus protests that it is not a new unit. If Mr. Kent objects to a single new unit, or rather to the substitution of a rational for an irrational unit, why does he thrust upon engineers a whole system of new and complicated terms?

Objection is made to the kilowatt, or its multiple, on the ground that it is not derived from fundamental units, as is the horsepower. Superficially, this would seem like a real argument especially when we think of belted generators, and all kinds of mechanical transmission in vogue before the advent of the electric generator and motor. But in these days, the call is for direct-connected prime-movers and auxiliaries.

The best steam-engine indicator gives only an approximation of the power delivered by an engine, while there is nothing to take its place on the steam turbine. Even the brake method of power determination is usually inaccurate, and is 100 per cent wasteful. On the other hand, with the electrical method of testing, all the energy developed may usually be utilized, and the most accurate possible determinations are made. With most direct-connected units, it is impossible to separate the mechanical from the electrical power, and with machines where this can be done, the best way of testing in practically every case is the electrical method. Thus for a long time to the majority of engineers a unit founded on the watt appeared to possess remarkable advantages over the horsepower as a unit for power measurement. Besides, the watt or kilowatt is used everywhere. There is only one kilowatt and every engineer in the universe knows what the word means. But when one mentions the word horsepower, who knows whether he means boiler-horsepower, indicated-horsepower, brake-horsepower, heater-horsepower, economizer-horsepower, electrical-horsepower, or continental-horsepower?

It is stated that mechanical engineers think in horsepower and find the term in all their reference books; but this is true only of English speaking people, and English and American reference books. Even though Mr. Barrus avers that the con-

version of units from one system to that of a foreign country involves only easy mental arithmetic, it is a sure gamble that to do so, most engineers would have to consume an abnormally large quantity of mental energy. When we have an international unit in use which could be universally applied every day, why do we still burden ourselves with a term of only local use and meaning?

The myriawatt was proposed principally for three ends:

a To substitute a unit founded on the C. G. S. system for a local unit, the boiler-horsepower, without effecting any radical changes in rating of energy converters.

b To supply a term which would connote power quantities on the input side of prime-movers, based on the same system as that of the accepted unit of output.

c To form a wedge for driving home the metric system of measurements.

Nearly all admit that the term boiler-horsepower is bad. Some suggest that the kilowatt might serve the same purpose as the myriawatt. This would almost be admitted were it not for the fact that the term kilowatt as used in connection with a power plant has become almost inseparable from the output. Besides it requires no real effort to think of a 600 boiler-horsepower boiler as a 600 myriawatt boiler, while it requires much imagination of the average man to rerate a 600-horsepower boiler as a 6000-kilowatt boiler. The myriawatt will in time connote the power on the input side of prime-movers, just as the kilowatt now universally suggests output.

Although in the paper on the myriawatt all terms were reduced to B.t.u., this was done only for the convenience of users of the local British system, the ultimate aim of the authors being to open the door to the universal use of the metric system. The fact that the British thermal system is tied to the factor "32 deg. above 0 deg" is enough to condemn it as complex. Who is there who has not at one time or another omitted or inserted the factor 32 in the wrong place with sad results?

Objection is made to the prefix "myria" that it does not convey a definite quantitative meaning. But if every grammar school graduate has been taught the relationship of the "myria gram" to the "gram," and of the myria meter" to the "meter," would it not be surprising if the engineer with all his training could not apply the easy analogy to the "watt"?

Were it not for the inevitable confusion in terms, it might be as well to rerate the boiler-horsepower as being equal to 34,150 B.t.u. per hour instead of 33,479 B.t.u. per hour. The prefix "myria" was thought to convey most clearly the relative quantity meant, while the "watt," named after the pioneer practical boiler-room engineer, will bring the mechanical department into harmony with the universal system of measurements.

The only real argument against the myriawatt is its newness. But its great benefit will be the linking of the mechanical with the electrical, and the internationalizing of our electrical and mechanical units.

H. G. Stott. Messrs. Kent and Barrus have criticized this recommendation very severely, and in doing so they have advertised the proposed change a great deal better than I could have done. The object of the myriawatt is to do away with the anomalous position which we now have in regard to the use of the term horsepower. If I should put the question, what is horsepower, to a body of engineers there would probably be at least five different answers. The man interested in economizers would tell me one thing as to horsepower; the man interested in boilers would tell me in square feet; the man interested in reciprocating engines would tell me it is the indicated horsepower; the man interested in other apparatus might speak of brake-horsepower, while the man interested in steam turbines would say "I don't know because there is no way of measuring it." The units have become so large they are almost invariably coupled to centrifugal pumps, blowing apparatus or electric generators. There is no way to separate the electrical or power output of the unit and the input, so that horsepower has ceased to have any meaning so far as the large producer of prime-movers is concerned. The steam turbine today is the type of unit which is being adopted for all purposes, marine, through gears, electrical generation, and for almost every purpose, because it seems to be much simpler and also because it involves a much lower initial cost.

Mr. Kent says that the mechanical engineer thinks in horsepower. Just what is horsepower? I have tried to find out, and there are at least half a dozen different kinds. I don't know which one you mean, when you say horsepower.

He also refers, I think through a mistake, to the definition of

the myriawatt, which is the same thing as saying that the myriawatt is 10,000 times the watt. It is not an electrical unit, but a dynamical unit. It is a non-gravitational unit and therefore independent of the weights or position on the earth in which the measurement is taken. It is equal to the acceleration produced by force equal to one erg upon a mass of one gram having a uniform velocity of one centimeter per second. There is absolutely nothing electrical about that, so that the evident objection which both Mr. Kent and Mr. Barrus make, that we are trying to introduce an electrical unit into mechanical engineering, is wiped out because the fundamental definition of today is ten to the power of seven C. G. S. dynamical unit.

This system has been adopted officially by 22 governments, that is, practically every civilized government of the world has adopted the C. G. S. system officially and it is legalized in all those 22 countries. In comparing the results obtained, for example, by a power station having turbines with those obtained in Europe, it has been my misfortune at various times to have to turn kilograms and calories into B.t.u. and finally to resolve the whole thing into pounds of steam per kilowatt-hour. We cannot say per horsepower, and we are practically forced to use the kilowatt or some multiple of the watt as a unit of power. It is a very happy thing because it will advance the internationalization of our system of units and make them comparable with the results obtained in Europe.

A number of other objections have been raised: Mr. Kent says the authors have taken up this old and discredited unit. I take issue immediately with the author of this article by saying that the boiler-horsepower is not an old and discredited unit. I wonder how many boiler tests are worked out today without referring to it. I personally have never seen any. It may be discredited in his mind but it is not discredited in practice. It so happens that the myriawatt, which is simply 10,000 watts, is almost exactly equal to a boiler-horsepower, there being just 2 per cent difference, and this nominal change would have no influence upon actual practice. The rating of boilers as to whether it is 2 per cent plus or minus is negligible for we all know a boiler is not driven at rated horsepower. We then have to consider the method of comparing it directly with the output on the switchboard or in whatever shape it may be, as the watt being a dynamical unit can be considered. Another considera-

tion was that the average thermal efficiency of the ordinary plant today is about 10 per cent, that is to say, take the thermal input in units of ten and you usually come out with about one at your switchboard, so that one myriawatt input in the boiler would represent about one kilowatt on the switchboard, some plants doing as well as 12 or possibly 13 or 14 per cent efficiency.

Mr. Kent gives a definition of the gram as one which involves the question of gravity. I particularly pointed out that mass has absolutely nothing to do with gravity: it is a non-gravitational unit. The criticism, therefore, does not apply. Mr. Kent, by objecting to the introduction of a new unit and recommending six new units, has himself very effectually answered his own criticisms.

Mr. Barrus criticizes the use of a new unit of power and afterwards corrects himself by saying it is simply a new multiple. He refers particularly to the British thermal unit as the only absolute standard countenanced. That is not so. I believe the next step will be the introduction of the centigrade thermometer scale. We are all familiar with the difficulties, especially the younger men, which have been encountered in the use of the 32-deg. freezing point. There is always a plus or minus position there which might lead to errors in calculation; and by having the freezing point zero, instead of 32, we avoid that. The centimeter gram second system is in use today in the United States. Every chemist uses it. When we send in a sample of coal to him for analysis, he uses grams and brings out the results in calories and then converts back to B.t.u. All that could be avoided by the introduction of the centigrade scale, which is today exclusively used in electrical measurements, in chemical and electro-chemical and metallurgical work, so that it is no great step to introduce the centigrade schedule into steam boiler or thermo-dynamic calculations.

What would Mr. Barrus measure the power of a turbine of 25,000 or 30,000-kw. capacity? Would he put a brake on it? He cannot separate the mechanical and electrical; he must measure the electrical output. All garantees of the turbine unit are given in terms of the output on that unit because there is no other way of measuring it without wasting an enormous amount of power. This, therefore, is another reason for adopting the proposed change.

THE PRESENT CONDITION OF THE PATENT LAW

INCLUDING RECENT AND PENDING DECISIONS OF THE SUPREME COURT OF THE UNITED STATES AND PROPOSED PATENT LEGISLATION

By Edwin J. Prindle, Published in The Journal for April

ABSTRACT OF PAPER

The decision of the Supreme Court in the Mimeograph case, sustaining the right of the patentee to require the purchaser of the machine to buy of the patentee ink and paper for use on it, has resulted in the introduction of a large number of bills in Congress, with a view to cutting down the patentee's monopoly. This paper explains the Mimeograph decision and, incidentally, the general nature of a patent and the monopoly which it grants, and explains the Bath Tub case recently decided by the Supreme Court; the price-restriction case of Bauer vs. O'Donnell, now before that Court for decision; the relation of the patent law to the Sherman act; and the general nature of the proposed legislation and its effect on the patent law, and upon manufacturers and inventors.

DISCUSSION

J. Nota McGill.[1] Mr. Prindle's paper should awaken the members of the Society to a realization of the necessity for vigorous protest against the enactment of dangerous legislation aimed at the fundamentals of our patent system, and which, if enacted, will be a fatal step backward and tend seriously to impair that set of laws which has done more for mankind physically, socially and financially, than any laws on our statute books.

The growth of that system has been co-extensive with the growth of our country; it can truthfully be asserted that to the growth of the inventive genius of our people is due America's great progress. The increase in population in practically the last 60 years of the 19th century was about 530 per cent; the increase in patents about 6400 per cent. At the beginning of the 19th century the world knew nothing of telegraphy, telephony,

[1] Secretary, Patent, Trademark and Copyright Section, American Bar Association, Washington, D. C.

Presented at the Spring Meeting, Baltimore, 1913, of The American Society of Mechanical Engineers, 29 West 39th Street, New York. All discussion is subject to revision.

steam navigation, or the myriads of labor-saving devices, the introduction of which has revolutionized the social, financial and commercial world. At that time agricultural products constituted our export trade. Manufactured products were nearly all imported, as it had been England's policy to suppress all industries of this kind in the colonies.

The American inventor could, with justification, claim much at the hands of his country; he asks only for fair treatment. In the grant of patents for inventions there is no undue advantage bestowed upon any man; the inventor is given the right, for a limited time, to *exclude* others from practising his invention, on the condition and with the express understanding that he shall disclose and make known to the world what he has produced, so that at the expiration of that limited period the public may be free to use his invention without payment of tribute.

Until a few short months ago no serious complaint was heard against our patent system. Then suddenly came the proposed amendments. If we look for a cause it is difficult to find, unless it be the methods adopted by the Shoe Machinery Trust. But even granting that their methods were the cause, it is a safe assumption that had there been no dissenting opinion in the Dick case we would not today be confronted with menacing legislation. There has been no public clamor for a change. The pronouncement in the Dick case involved no new proposition of law. The decision in the Button Fastener case was rendered in 1896, and for 16 years thereafter (nearly the lifetime of a patent) the commercial world accepted the doctrine of that case practically without question, and the public suffered no hardships. The public are not required to take what the patentee offers if his terms are unreasonable. If they subscribe to the conditions imposed it is but a tribute to the value of the invention. If, on the other hand, they are not accepted, the public are deprived of nothing to which they had any legal or moral right. The patentee is alone the sufferer if in consequence of his attitude he is without a market, and this fact alone precludes him from ever imposing unreasonable demands. The American public can be depended upon neither to require nor to accept unfair conditions in affairs of business.

The other radical change now advocated (compulsory licenses) is even more dangerous and less justifiable than the curtailment of the right to dictate the terms of use and sale.

It has been said that the patent privilege "encourages the inventor to bring his invention to the highest possible condition of practical utility by inventing improvements on it constantly, in order to keep pace with the public wants and to control the trade from which his compensation is derived." But this stimulus to improve will no longer exist if the patentee is to be penalized because of the improvement.

Mr. Edison stated to the committee of the House that while he had heard and read numerous statements that many corporations buy valuable inventions to suppress them, he did not know of a single specific case of suppression. When Mr. Fish asked the committee if during the hearings or at any time there had been brought to the attention of the committee a single specific case of suppression, he was told that *one man* had stated instances where his own inventions had been suppressed. Considering the fact that over a million patents have been granted in this country, the complaint of a single or even a hundred or more persons is practically negligible.

It is unreasonable to assume that the American manufacturer would for a moment refrain from placing on the market an invention that would insure a fair return on the investment. American capital has never been known to indulge in such pastime as is suggested by a handful of persons demanding privileges which the law has always reserved to the inventor and those claiming under him.

Once suffer such an amendment to be made, and a serious blow will be struck the inventors of our country. Capital, ever apprehensive, will hesitate to accept the risk entailed: the inventor will find it more difficult to secure support; and progress will be arrested if the cost of adopting an improvement may mean an advantage to competitors, royalty or no royalty.

Action and untiring action alone will avert the impending dangers pointed out by Mr. Prindle. Concede to the members of the committee of the House the best motives, they are not actuated by any desire other than to discharge their duties honestly and faithfully. It is within the power of the members of this Society interested in maintaining the integrity of our patent system to impress upon every member of Congress that the proposed changes are not desirable, but on the contrary will prove a decided menace.

The author did not desire to present a closure.—Editor.

COST OF UPKEEP OF HORSE-DRAWN VEHICLES AGAINST ELECTRIC VEHICLES

By W. R. Metz, Published in The Journal for April

ABSTRACT OF PAPER

A great deal has been written on the subject of motor trucks versus horse-drawn vehicles, but it appears to be extremely difficult to obtain exact figures, as most firms regard the item of hauling as an overhead expense not worthy of the minute examination given to the other departments.

The motor-driven vehicle is unquestionably cheaper to operate than is the horse-drawn vehicle where a number of vehicles are used, and, in the opinion of the writer, the only question to be determined is the advisability of using electric or gasolene-driven machines. From figures on hand, it appears that the cost of upkeep of the gasolene-driven machines is about double per mile that of the electric-driven machines (not including driver's or helper's wages), but, on the other hand, the gasolene-driven machines have a much larger radius of operation and, in certain cases, this would more than offset the cheaper upkeep expense of the electric-driven machine.

As a general proposition, it appears that the electric-driven machine is better for city service where the streets are in fairly good condition, and that the gasolene-driven machine is better for long hauls over rough roads and in the open country, mainly on account of the ability to obtain gasolene and water, and the chances of making greater speed.

DISCUSSION

H. H. Smith.[1] Scientific cost keeping is unfortunately a very modern practice, and we who must displace outworn institutions with new and better ones are at a disadvantage because there is nothing tangible available concerning the old.

The saving effected by the substitution of power trucks in the case cited by Mr. Metz is surprising, as it is not unusual for the cost of operation during the first year to be reduced very little. Usually this is because the delivery routes and system have not been altered where necessary to fit the new conditions. Obviously if an electric truck is given the work of a horse truck on

[1] Edison Storage Battery Co., Orange, N. J.

The American Society of Mechanical Engineers, 29 West 39th Street, New York. All discussion is subject to revision.

the horse-truck schedule, the cost per delivery will be much higher because the advantages of the motor-driven vehicle will not have been properly utilized. The case under discussion indicates what may be accomplished by careful study and rearrangement.

Another point brought out in the paper which confirms other investigations along the same lines is the insignificance of the cost of energy in the operation of electric vehicles. It seems to run generally between 6 and 10 per cent of the total cost. Repairs and depreciation usually constitute a greater item of expense, while the cost of labor ranges from 40 or 50 per cent up. These relations should be carefully borne in mind when the purchase of trucks is under consideration.

It is an interesting fact, brought out more clearly in other investigations, that the advantage of the electric wagon over the horse wagon increases with the distance of the delivery zone from the starting point in light parcel delivery, and with the weight of the load in work near the point of distribution. It is even recorded that the horse may be of slightly less cost in congested territory where the radius of action is small and the number of stops large.

It is stated in the abstract of the paper that possibly the gasolene truck meets with favor in certain classes of service because of the ease with which fuel may be obtained. This may be true today, but it will be a matter of only a very short time when power companies will have boosting stations in as large numbers as could be desired and there will also be garages with boosting facilities when the demand is present. If careful study is given to the transportation problem, however, boosting will not be required in commercial service except where it has been specifically allowed for in the design of the vehicle.

A. M. Pearson.[1] The principal feature which Mr. Metz's paper indicates is the fact that the horse is a thing of the past. It does not take a long stretch of imagination to see why this is so when you take into consideration that the volume of business of this country has increased about 165 per cent in the last ten years, and that the number of horses and mules has only increased about 10 per cent: therefore, the only means by which this increased business, which means increased distance, as well as increased

[1] The Locomobile Company of America, 2314 Market St., Philadelphia, Pa.

volume could be overcome, was to substitute a mechanical method of transportation for a physical method. But there are still many serious problems facing truck manufacturers and truck distributors, the largest one of which is the one called the customers' problem; that is, methods by which the short haul and the facilitating of loading and unloading of merchandise, and the increase of the efficiency of a single unit in the form of a truck may be accomplished.

There are still many things to be desired. For instance, the company that I represent makes a truck with an engine which has a capacity of 45 h.p. It is obvious that there should never be a state of affairs where a truck with such an engine would stand idle while six or eight men load it. The power of this engine should be utilized in every instance for loading and unloading, and all the concomitant features of transportation to bring into existence the full efficiency of a motor vehicle.

We know how to build a chassis; we know how to build engines, both electric and gasolene; but there are many other things which are directly in line with the craft which this Society represents that are badly needed and clearly indicated. For instance, we need folding boxes, and we need them very badly. There have been many folding boxes placed on the market, but there seems to be some weakness in the hinges, which prevents the article from being a practical part of transportation.

We need different types of dumping bodies from those that are now offered to the public by body makers. Too many people are trying merely to place a truck instead of so many horses, and too many body builders are offering us the same conditions as we had with horse wagons. What we need are bodies that are made and adapted especially for motor vehicles. We need different power appliance; we need a satisfactory winch for a truck; we need a satisfactory crane for a truck, and in all these appliances we need a condition whereby the number of men necessary to operate them is reduced to the minimum.

L. H. Flanders.[1] The general agreement in results and conclusions of the paper with the reports of the electrical engineering department of the Massachusetts Institute of Technology in its exhaustive investigations of The Economical Transportation of Merchandise in Metropolitan Districts, is observed.

[1] The Electric Storage Battery Co., Philadelphia, Pa.

In the last report, Vehicle Research Bulletin No. 3, presented last March before the Electric Vehicle Association, Messrs. Pender and Thompson show how important is the study of service requirements, in securing a proper selection of the size and type of vehicle to give a resultant minimum cost. Among the figures they present the time the wheels are in motion to the time the vehicle is in service, i.e., the mileage factor, is most impressive.

Referring to Mr. Metz's paper, Table 13, the average mileage per day runs from 20 to 24 for the electrical vehicles at a cost of from 33.8 to 36.1 cents per mile, of which roughly two-thirds is labor for drivers and helpers, while with the horse-drawn vehicle the driver and helper wages amount to about 44 per cent of the cost per mile. Anything therefore that will increase the percentage of the time the wheels are turning will decrease the cost of operation per mile.

It would also appear that with a mileage factor such as would necessarily exist it would often be foolish to run even a 2000 lb. capacity vehicle continuously at the speed that now prevails. With a reduction of speed, vehicle and battery maintenance drop an amount well worth the sacrifice. To illustrate: Assume from Table 13 that the 2000-lb. electric truck is in service 10 hours. It has a maximum speed on the level somewhere near 12 miles per hour, and an average speed of say 8 miles per hour, which would mean for 20 miles per day an actual running time of 2½ hours, with an idle time of 7½ hours. By cutting the maximum speed to 9 miles per hour the time of running would be increased to only 3 hours, which would necessitate a reduction of half an hour in the idle time, or approximately 7 per cent. This is particularly true in congested city streets where it is impossible to utilize the high speed on account of frequent stopping and starting.

Effecting this change through increased gear ratio would mean reduced battery draw for a given tractive effort or a greater tractive effort for hills and greatly reduced vehicle and tire depreciation. To the very fact that the electric vehicle is a so-called slow-speed machine may be attributed one of the reasons for its superior economy in nearly every situation over the commercial gasolene vehicle. The larger the scale upon which the electric vehicle is used the greater is the economy, particularly in battery efficiency and maintenance.

The radius of operation with electric vehicles has been much increased in the last few years by coöperation between the vehicle

manufacturer, the motor manufacturer and the battery manufacturer, each designing his part to make a harmonious equipment suited to the particular service.

Attention is called in the abstract of the paper to the larger radius of action of the gasolene machine as well as to its greater cost of operation as compared with the electric car. In this connection there would appear to be many an opportunity for increasing the radius of action of the electric vehicle by changing batteries or boosting during periods of idleness at outlying distribution points, or at the home loading platform during the noon hour.

In many delivery systems it is the practice to carry merchandise to outlying substations in large gasolene transfer trucks and from the substation to the points of ultimate destination in electric delivery wagons. In collection service the process is reversed. Many of these substations readily lend themselves to taking care of large electric transfer trucks by allowing for changing batteries which will take from 20 to 30 minutes, or by providing facilities for boosting charges. By changing batteries the radius of action of such trucks is, of course, doubled.

The lead storage battery, particularly with that form of construction using protected cores, is adapted to be recharged at exceedingly high rates and with remarkable efficiency for short periods. To be specific, that form may be recharged at an energy efficiency of over 84 per cent and a current efficiency of upwards of 97 per cent. The battery may be recharged at a rate in amperes equivalent to its state of discharge in ampere-hours. This would, of course, mean a decreasing rate of charge. This can be secured practically by providing a constant potential circuit of approximately 2.3 volts per cell, and simply by plugging in the battery without intervening resistance. By this method of charge with 100 per cent of the battery discharged 23 per cent can be restored in 20 minutes; 32½ per cent can be restored in 30 minutes; 52½ per cent can be restored in 1 hour.

With the battery three-quarters discharged 44 per cent of the total capacity can be restored in one hour, giving a total capacity of 144 per cent of the normal capacity on one charge and a corresponding increase of mileage per charge.

Where constant potential circuits of suitable voltage are not available, the battery may be boosted at a constant current, provided gassing (which means wasted energy), and high tempera-

tures are not produced. A safe rule within this limit is to charge at a current rate in amperes equal to the discharge state of the battery in ampere hours divided by the time in hours available for charging, plus one. To illustrate: The ampere-hour meter shows 100 ampere-hours have been discharged from the battery; one hour is available for boosting; the charging rate will be $\frac{100}{1+1} = 50$ amperes for one hour. If 15 minutes are available for charging the rate would be $\frac{100}{1+0.25} = 80$ amperes and the input would therefore be 20 ampere-hours.

Referring to Table 11, this figure would mean on the basis of 3.69 ampere-hours consumption per mile with 95 per cent current efficiency, about 13 miles increased action with one hour available for boosting.

An ampere-hour meter would be necessary as a guide in following this method, and in general the results would be as follows: A vehicle after having given 40 miles on a charge could be boosted so as to give additional mileage as follows: in 20 minutes, 10 miles; 40 minutes, 16 miles additional; 60 minutes, 20 miles additional; 80 minutes, 22.8 miles additional.

The same vehicle could be boosted for one hour after having given 10, 20 and 30 miles from a fully charged battery so as to give 5, 10 and 15 miles respectively.

These data show the possibility for long hauls and the flexibility of application of the electric vehicle.

WILLIAM P. KENNEDY.[1] There is general demand for operation cost information such as is given by Mr. Metz. There has been considerable difficulty in getting accurate cost information from users of motor vehicles, particularly for the reason which is illustrated in this paper, that the installations are made partially instead of completely, and with the partial installation retaining part of the former horse installation, it is hard to segregate cost to do justice to the motor vehicle. Mr. Metz's paper has taken care of this very nicely and shown differences in cost as to partial, initial and final installation. The best practice would be completely to analyze the situation first and prepare a statement of the operating costs, and to use that as a standard

[1] Consulting Engineer, 1790 Broadway, New York.

table, so to speak, by which the entire proposition might be worked out. It is not just nor desirable to make comparison of unit costs of large motor equipment as against the cost of the horse-drawn vehicle in the horse-equipment installation; the only way to arrive at cost in either horse installation or motor installation is to take the entire cost of operation, preferably on an annual basis and, with all the charges against the installation, determine the operating unit cost.

JOHN YOUNGER.[1] In the abstract of the paper there is a statement rather damaging to the gasolene truck, and not at all substantiated by the figures given. Many like statements are made by those favoring the electric storage battery truck, but when the test of actual accounting is applied, they are found to be without actual foundation in fact.

The only gasolene cars mentioned in Par. 8 are Cadillac, Brush, Buick, Ford, Franklin and Maxwell cars. These are distinctly not commercial vehicles, as properly understood, but merely touring cars, probably specially adapted. These cars run at high speed and it is a well-known fact that it is exceedingly difficult to keep the drivers from abusing them by stolen "joy rides" and by fast driving over bad roads. For these and many other reasons, their cost of operation is on the high side, but should not be as high as stated in Table 5 if there had been careful supervision. For instance, the running sheet of a gasolene 5-ton truck selected at random shows that it ran at a cost per mile of $0.267, i.e., exactly twice the cost of running the so-called gasolene commercial car in Mr. Metz's paper.

It may be interesting to state here the method used by the Pierce-Arrow Motor Car Company in taking operating costs of their 5-ton truck. It will be noticed that every item of importance in determining a true and accurate cost is taken into account, including insurance and garage charges, and a reasonable interest at 6 per cent per annum on the investment. Mr. Metz's figure of 2 per cent on Table 12 is altogether too low, though, of course, in agreement with that allowed on his horse-drawn vehicles.

Investment of truck with full equipment, including body and all tools.....$4800.00

[1] Mechanical Engineer, Truck Department, The Pierce-Arrow Motor Car Co., Buffalo, N. Y.

Interest at 6 per cent per annum	$288.00
General insurance	200.00
Garage at $30 per month	360.00
Driver at $21 per week	1092.00
Fixed charges per year	$1940.00
Fixed charges per day (1/365)	5.32

RUNNING COSTS PER MILE

Tires (8000 miles guaranteed) at $468[1]	$0.05850
Gasolene, 4½ mi. per gal. at 18 cents per gal	0.04000
Lubrication	
Motor, 250 mi. per gal. at 60 cents per gal	0.00240
Transmission, 5000 mi. per 5 gal. at 65 cents	0.00065
Rear Axle, 5000 mi. per 5 gal. at 65 cents	0.00065
Allowance for daily repairs and overhaul (maintained and overhauled at 15,000 miles)	0.02500
Depreciation at 150,000 miles, or seven years	0.03200
Operating expenses for 1 mi.	$0.15480

These figures are based on actual average working and can be considerably improved on by careful supervision. Tire mileage, for instance, can be bettered by the driver exercising precaution on bad roads.

We find that the field of the gasolene truck is limited only by the length of the highways. We have 5-ton trucks operating successfully in short hauls as well as long hauls. There is a very good description of a short haul job in the Engineering Record, October 26, 1912.

In our experience a comparison of costs with horse haulage is rarely asked for nowadays. There are many other benefits accruing beyond monetary saving. Users, for instance, are able to extend their territory and push sales at greater distance. Other users find the saving in time a valuable item. Still other users are operating trucks successfully where horses and mules are practically impossible. The extremes of heat and cold in our climate have rendered the horse an "unstable" animal, and the motor truck, electric or gasolene, is surely replacing him.

E. R. Gurney.[2] In Table 8, the operating expense of a two-horse team is given as $1559.24 per year, which, reduced to a ton-mile basis, assuming 12 miles per day, 300 days, loaded one way,

[1] Based on cost at present time.

[2] Knox Automobile Co., Springfield, Mass.

gives 33 cents per ton mile. This figure checks very closely with an average of horse-drawn costs as we have been able to compile.

In Table 12, the operating expense of a 5000-lb. electric truck reduced to a ton-mile basis is 27 cents per ton-mile assuming 24 miles per day 300 days. This is within 1 cent of the result obtained as an average of our 6000-lb. gasolene truck.

We have no data on electric operation nor on the lighter gasolene delivery systems. Our data begin where this paper leaves off and deal with the heavier class of units reduced to a cost per ton-mile basis.

HARRINGTON EMERSON. Reliable and adequate comparative records of costs of motor trucks and horse-drawn vehicles at the present time would be exceedingly valuable. The conclusions reached are not satisfactory, however, as the data are not standard. For instance, in estimating the cost of a truck Mr. Metz puts down interest at 2 per cent per annum which is not a legitimate industrial charge. Six per cent, perhaps 7 per cent, and in certain portions of the country even higher, would be the very lowest that ought to be charged. Depreciation is put down at 10 per cent. There is inadequate experience to justify the assumption that the depreciation of an electric motor truck is only 10 per cent per annum. In ordinary machinery we assume about 10 per cent a year for depreciation, and certainly on such an article as a motor truck, 10 per cent is too low for depreciation. On the other hand, when it comes to the horse-drawn vehicle, we have the statement that five carts, five horses and five men were displaced. How do we know that three men could not have done the work perfectly and three horses and three carts? Usually these horse-drawn vehicles are not operated at more than 60 per cent of possible rational efficiency. It is absolutely impossible to compare a truck operating probably at 100 per cent efficiency and a horse-drawn vehicle whose efficiency we do not know. In one table the horse-drawn vehicle is put down as costing $1.92 a day and in the very next table the cost is put down at $1.55, showing no standard of costs. What evidence is there that a horse-drawn vehicle ought to cost $1.92 a day? If the $1.92 is not correct, is merely a record of incidental cost instead of in any way being a standard cost, all conclusions drawn from the figures are invalidated.

CHARLES W. BAKER. I do not see why 6 per cent interest should be charged on an investment in horses and only 2 per cent on an investment in electrical trucks. The figures on depreciation also seem open to criticism. Mr. Metz allows 15 per cent depreciation on the horse-drawn commercial vehicle, but I know of such vehicles that have been used for many years and are not yet worn out. He charges the same rate of depreciation on the motor vehicle, but my observation is that the depreciation of such vehicles is very rapid indeed. I think Mr. Metz's figures should be critically studied by anyone proposing to rely upon them for practical guidance.

THE AUTHOR. Mr. Flanders recommends a reduction in speed, giving as his reason therefor, that it would greatly reduce vehicle and tire depreciation. While it is true that the speed reduction would reduce this depreciation, it should also be remembered that a necessary reduction in speed in congested city streets makes it imperative to obtain a higher speed at certain times in order to get mileage out of the cars sufficient to make them pay. The exact speed at which commercial vehicles should be run is open to question, but I believe that the present speed is about as nearly right as it can be made under present conditions.

Referring to the discussion by Mr. Emerson, it is my opinion that interest charges should be made to agree with the actual interest which any particular establishment has to pay. If the government can borrow money at 2 per cent, it is fair to charge 2 per cent interest on investment for government work. If private establishments have to pay, say 4 or 5 per cent, then they should charge 4 or 5 per cent interest on their investment.

The figures in my paper were given from actual experience, and the charges were therefore made to agree with the facts in the case.

It will be an easy matter for anyone desiring to install automobiles to separate the interest charges and make his particular interest charge agree with the interest which he will have to pay.

The remarks made by Mr. Baker hardly need any criticism, for it is apparent that he has not read the article correctly. A detailed examination of the article will show that for any given establishment the same interest is charged against electric trucks as was charged against horse-drawn vehicles, and in government

establishments the same thing is true. Mr. Baker evidently confused the figures by comparing the horse-drawn vehicles used in private establishments with the electric vehicles used in government establishments.

Referring to the depreciation charges, it is a well-known fact that the horse is not much good for heavy trucking service after five years of use, and the horse-drawn wagon is not much good for the same service after ten years of use, so that the 20 per cent depreciation on the horse, 10 per cent on the wagon, and 15 per cent on the harness represent average figures. The depreciation on electrics is, of course, not yet well understood, but there are plenty of electric vehicles in use at the present time which were purchased ten years ago, or more, so that the 10 per cent depreciation for this class of vehicles is on the safe side.

TEST OF A HYDRAULIC BUFFER

By Carl Schwartz, Published in The Journal for June

ABSTRACT OF PAPER

The paper discusses the performance of a hydraulic buffer for railroad terminal stations and the means used for the test. The results show the energy absorbed by the buffer under various conditions of train speed and weight and indicate how a buffer should be constructed to be least harmful to the train equipment.

DISCUSSION

F. H. Clark. One of the important elements in any device intended to absorb the shock or arrest the speed of moving bodies is the length of stroke or the distance through which the device operates. The disadvantage of the ordinary type of buffer or stop as used in railway service is the relatively short movement of the face of the buffer. In the hydraulic buffer described by Mr. Schwartz, this difficulty is overcome to a great extent by the stroke or working length of 11 ft., and the tests naturally show that desirable results are obtained. The device has the disadvantage, however, of occupying a considerable amount of space. The length over-all is not given, but it would probably not be less than 30 ft., or about 20 ft. more than is occupied by the usual type of buffer. This would be an important item in a large terminal, not only on account of the additional space required, but also on account of the greater distance between the train and the station.

Buffers as a rule are intended only for emergency use and are very seldom brought into action. It is generally desirable that such equipment be of such construction that casual inspection will determine whether or not it is in working order, and there might be some liability in cold climates of the device freezing or otherwise becoming inoperative without its condition being noticeable.

Arthur E. Johnson. This buffer could be designed so as to be

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similar to the simpler forms of brakes used to take up the energy of the recoil of guns, as follows:

First by ascertaining as nearly as possible the amount of pressure which a given train construction will stand as a resistance. Then the length of action of the buffer can be arranged as permitted by the space available and as required by the weight of trains. Cylinders may be arranged either horizontally or vertically to save space. They may be provided with a by-pass if necessary to handle trains very much lighter than the maximum. The lighter resistance thus provided would permit the same length of action for the light as for the heavy trains. And last, solid bumpers must, as before, be provided to prevent the pistons from bottoming whenever the energy is too great to be taken up entirely in the device.

Oil would seem to be a much more suitable fluid for this use than water on account of its greater viscosity.

H. A. Jensenius.[1] In traveling through Germany and England last summer, I saw a buffer in Düsseldorf and also one in England, the construction of which was similar to the one described by Mr. Schwartz, but the stroke I believe was not more than 8 ft. At crowded terminals space is very precious, and therefore if an apparatus of this kind could be built with a little shorter stroke and probably with a larger cylinder or higher pressure, it might be better adapted for the purpose intended.

Another point is the question of freezing. These buffers are filled with liquid and subject to low temperatures. Therefore, water would not be suitable. A device arranged with a closed pressure tank so as to confine the liquid and not to require any outside source of supply would in my judgment be more serviceable. In this case oil or any other non-freezable fluid could be used.

Philander Betts. The curves showing the results of tests of the stoppage of trains made by the use of this apparatus show the great importance of the draft gear. I would like to have the question answered, if it can be, as to whether note was made as to the types of draft gears and as to whether tests have been made with different types of draft gear to show the relative results in the stoppage of trains as indicated by the form of curve drawn by this apparatus.

The Author. The length of travel of the buffer piston is

[1] R. D. Wood & Co., Philadelphia, Pa.

largely influenced by the weight of the train striking the buffer and relatively little by the speed of the train, the speed of the train determining the pressure in the cylinder and thus the resistance against the train. The buffer is built for a maximum train weight of 1000 tons, and with about 11 ft. travel will be able to bring such train to a standstill. The length of the stroke could be shortened by increasing the pressure against the train with an increased liability of damage to the equipment.

Mr. Jensenius is correct in stating that buffers installed in Germany and England have a shorter working length, and the reason is that trains in Europe have smaller tonnage than in this country. The experimental buffer tested is the largest buffer of this type ever constructed, its total length being 30½ ft.

The suggestion is made to use another liquid than water. Inasmuch as the energy absorbed is all transformed into heat from a theoretical standpoint, water would be the ideal medium because it is the medium capable of storing the largest number of B.t.u. Practically, however, this feature is of little importance and the non-freezing qualities of oil or glycerine are more valuable. Water was used and disposed of to the sewer because the buffer is installed for experimental purposes, but for a permanent installation the suggestion to use a closed pressure tank to confine and circulate the liquid should receive careful consideration.

The tests were made irrespective of different types of draft gears and the curves in Fig. 8, which apply to a locomotive with four Pullman cars and a total train weight of 342.5 tons, show that a certain amount of energy was absorbed by the train itself due to the cars swinging back and forth during the impact. No doubt the type of draft gear has some influence upon the behavior of the train during the impact period.

SHADING IN MECHANICAL DRAWING

By Theodore W. Johnson, Published in The Journal for April

ABSTRACT OF PAPER

The object of this paper is to present a new rule for shading mechanical drawings, which comprehends the most important of the rules now used without their complexities and uncertainties and the controversies which arise from their use. The new rule is proposed with a view to reducing the art of shading to a precise and exact system in the interests of rapidity in the execution and reading of drawings and of their appearance.

DISCUSSION

Sanford A. Moss. It is questionable if shading really aids in reading a drawing. Fig. 1 would probably be as plain if it were unshaded, and Fig. 2 without other views could hardly be made plainer by any system of shading. Any mechanical drawing which depends upon the shading for its interpretation is likely to cause mistakes. Therefore, if we must use other means than shading to make the drawing plain there is no use going to the trouble of adding shade lines even though this trouble is very slight. That this is true is borne out by practice; 95 per cent of the mechanical drawings made today for regular shop use have no shading whatever. This has been a great evolution from the custom of ten or twenty years ago when shading was very prevalent. The writer has made a number of tests with actual mechanics, and a number of investigations as to the prevalence of shaded drawings in shop work. As a net result the decision was reached that mechanical drawings should not be shaded.

The view taken by Mr. Moss was expressed in various ways by other discussors, and the Editor has omitted repetitions of such statements.

Wm. P. Hawley. If the object of shade lining be to reduce the number of necessary views, and so make one view serve where

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two might otherwise be needed, the time saved in the drawing of views, will be consumed in the study and execution of the shading, and the drawing will not be so clear in the end. The mental effort required to interpret a drawing of one view with shade lines is doubtless greater than that required to understand the same drawing with an extra view and no shade lines, and there is far less chance for dispute in the latter case.

The author's closing sentence intimates that theory and practice are not now in accord, but will be when his new rule is adopted. When theory and practice are in conflict, it is safe to side with practice; present practice is for plain, legible, and unornamented shop drawings, with sufficient views of each detail to show all that shade lines might otherwise attempt. The best drawing for the shop man is the one that will give the most complete information in the simplest possible fashion: the one that can be made and interpreted with the least expenditure of time, and still leave no questions to be asked and no chance for disputes.

H. D. Hess. As the proper dimensioning of drawings requires that more than one view be given, anyone using drawings should read only one view as interpreted by the accompanying views. Failure to do this is quite noticeable on the part of students who not infrequently give up attempting to understand one view before examining the other views. Shading drawings for the use of students in engineering would only tend to increase their dependence on one view and would therefore be objectionable.

While not approving of any general adoption of shading in mechanical drawings, I believe the rule suggested by Professor Johnson would simplify shading and would prove satisfactory.

L. S. Burbank. In our drafting room no attention is paid to the shading of drawings; in fact, the rules explicitly state that no detail drawing shall be shaded. We standardize the strength of line of which the picture is made, and the strength of line of which the dimension and construction lines are made, so that the picture will stand out distinctly; these lines, however, are not made so heavy that they may not be conveniently and safely erased. Our layout drawings are generally made with differ-

ently colored inks, with the colors of the various details corresponding in the several views and with the full and dotted lines shown, generally, as if the detail showed alone.

But all this is special to our requirements; the general functions of the various styles or models of looms, etc., are so familiar that we need no emphasis put on the illustrative feature of the drawing, but are concerned principally with the changed form of the detail construction necessary to meet some new condition, and the colored ink enables the eye to trace and hold amid a labyrinth of other lines, the form of any particular detail. In ordinary shop working drawings I would not favor the shading of detail drawings.

In assembly drawings of relatively unfamiliar machinery, shaded work adds a depth and clearness, whereas colored line work shows it perfectly flat. Patent office drawing is a good example of the practicability and necessity of shaded work; and in practical machine design, particularly in assembly drawings where the mechanism is complicated or unfamiliar, shaded lines are generally an assistance. There are other cases, such as illustrative work where the intention is to beget admiration, which come under this class.

I think the rule for shading suggested by Professor Johnson is the best I have seen, and I shall certainly profit by it.

L. E. Osborne. The rules covering shading as given in the best text books on the subject ought to make their use clear. Prof. Gardner C. Anthony in his Machine Drawing covers the subject in the following concise paragraph:

> The only practical direction that may be given for the method of using them is to shade the right hand and lower edges of all surfaces, remembering that in the case of contact between surfaces, the line represents the surface nearest the observer. Where the surfaces are flush, as is the case between the stub-end of the connecting rod and the strap, the line must be fine. Never shade the intersecting lines between visible surfaces of the same piece, as illustrated by the division line of the faces of a bolt-head. Shade the lower right-hand quadrant of outside circles and the upper left-hand quadrant of inside circles. Do not permit the shade line to encroach on the surface which it bounds.

As Professor Johnson brings out in his paper, there is considerable variation in the use of shade lines. I believe this is due either to a drafting room holding to a method adopted a number of years ago, or to those in charge not requiring absolute uniformity of shading on drawings. Shading is by no means a dif-

ficult subject, and rules covering it, an example of which I have quoted above, make it clear.

Professor Johnson has covered his subject thoroughly and has ingeniously formulated a rule having both brevity and clearness. I believe this paper comes at an opportune time because it is unquestionably to the interest of both the engineering industries and profession that standard methods be used.

LUTHER D. BURLINGAME. In my experience with draftsmen I have found it difficult to bring about uniformity in the use of shade lines, due no doubt to the varying rules referred to in Professor Johnson's paper. As a matter of practice a large proportion of our work, when shaded at all, follows the general plan proposed by him, which has much to commend it.

I agree with the author in that reducing the number of shade lines to the minimum is desirable; practice at the Brown and Sharpe works is to use shade lines only for assembled drawings and sections, not using them at all on details or on tool drawings. The fact that tool drawings, and in many cases details, are made in pencil, blue prints being made directly from the pencil drawings, is another reason for not using shade lines for such drawings. While there is some advantage is using shade lines for the lower part of cylindrical objects in order that they may be distinguished from rectangular objects without an additional view, in practice this is of no great value because the variation in the work of different draftsmen is so great that it cannot be depended upon. It may be noted that while the rules of the patent office call for the light to come from the upper left-hand corner at an angle of 45 deg., a large proportion of the drawings do not strictly follow this rule. In fact it is an unusual experience to find any drawings which are entirely consistent in this respect. For these reasons I believe that the simple rule laid down in Professor Johnson's paper should be adopted as covering the best general practice and following what might be called "the line of least resistance."

F. W. IVES. I heartily approve of the author's proposal to change the direction of the ray of light to a position approaching the vertical. I believe that it will simplify materially the average draftsman's trouble in dealing with conflicting rules.

J. S. REID. About the year 1907 I made an investigation into the general practice in drafting-room conventions. Thirty-five questions were embodied in a letter to 200 selected progressive chief draftsmen in this country, and in reply to one of the questions the almost unanimous answer, "never use shade lines" emphasized the conviction in my mind that shade lines on mechanical drawings are not essential to the proper reading of a correctly made working drawing. It is true that shade lines give a certain embellishment and relief from the flat to drawings that would seem to be very desirable at first thought, but the extra time required to apply them and the confusion in methods of application have been thought good reasons among others for abandoning them.

With the exception of the practice of the United States Government it is my belief that shade lines on mechanical drawings have been almost entirely abandoned, and in these days of scientific management and the elimination of all unnecessary movements it would surely be going backward to give the impression that the use of shade lines on mechanical drawings are the proper things.

The new rule suggested by the author seems to be rather vague and would need a good deal of explanation to go with it to make it clear to the average student or draftsman. "If a ray of light comes from a point almost perpendicular to the paper, how can the projection of that ray make a 45-deg. line, as at present?" is a sample question asked by students on reading the rule. A good many years ago when draftsmen were quite generally using shade lines, the most satisfactory rule was to shade the lower and right-hand edges of all flat surfaces in shadow. Of course the rule was not entirely satisfactory, but it was the most popular practice.

J. G. MATTHEWS. From a practical standpoint the subject of shading in mechanical drawing seems to me to be one of minor importance. For several years, while in charge of the drawing room of a large concern in Michigan, I had all drawings shaded at a considerable expense of time and money. But since more than one view of an object is usually required in order to give the amount of the elevation or depression indicated by the shading, I feel that the other view or views are sufficient without shading. No shading is used in the East Technical High School in

Cleveland, and the pupils have no difficulty in understanding the drawings, though some of them are quite complicated; and if anyone were to be helped by the use of shading, it certainly would be students. I think that cases where it is worth while are very few.

THE AUTHOR. The discussion divides itself into two parts, on the proposed rule itself and on the desirability of shading in general.

The paper was not written with the intention of raising the general question, but since it has the discussion should be welcomed. On this question the writer wishes to take a middle ground.

The old practice of shading, whether necessary or not, was an economic waste. A rule to discard shading altogether is also wasteful, for it can easily be shown that in some cases the extra labor of executing the shading may save its equivalent many times over. The question is then a decision as to where to draw the line, and in deciding this the future history of the drawing must be considered. If a drawing is of a part whose general shape is well known and which may be handled only by a few persons, shading is entirely superfluous, for it is hardly more than a place to record dimensions.

Other drawings are to persuade engineers and laymen of the desirability of a new and unusual device or construction, or to teach students the construction of machines new to them. In such cases the little extra labor of shading may save its equivalent in time hundreds of times over. This is the explanation of the persistence of shading in text books, advertising books, patent drawings and professional papers. Many an engineer who is "down on" shading because he knows it to be a waste of time when applied to the detail drawings made in his office, will naturally adopt it when he writes something for a technical journal. He will then discover that in order to get his figures on a large enough scale for the very narrow printed page he must reduce the number of his views. If then a single view, shaded, can serve in place of two views, not shaded, he has gained, or rather the gain is to the user of the drawing in the ease of reading it. In order to have a rough and ready rule applicable in many cases the practice of shading assembled drawings and leaving unshaded detail drawings is spreading. It is a rule which follows the general idea that the simple drawing

for machinists' use does not require shading, and the complicated drawing for engineers does require it.

There is at present a tendency to fail to use shading even where there is distinct gain from it, due perhaps to the present state of confusion of rules. If the draftsman shading the drawing and the user for whom it is intended are not at one as to the meaning of a shade line in every possible case, it is clear that precision and time are lost and vexation caused which is attributable to the state of the art of shading, and not chargeable to shading per se. This I hope will be removed when a precise rule is generally adopted.

As regards the proposed rule of shading itself, it seems to be approved by some as simplifying shading and removing a "twilight zone" or debatable ground and making every question as

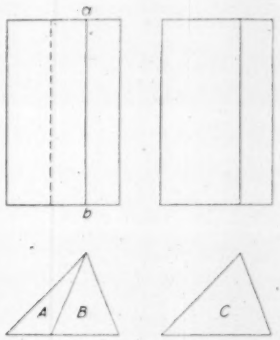

FIG. 14 AMBIGUOUS CASE OF SHADING

to shading one which can be answered with "yes" or "no." Mr. Osborne quotes a rule in Anthony's Machine Drawing as a concise paragraph, but to my mind it can only be interpreted in the light of a previous rule, defining the direction of light upon the object and it is subject to other criticisms. "Never shade the intersecting line between visible surfaces of the same piece." This rule is intended to be the same as rule V of the paper on Shading in Mechanical Drawing, but ambiguous cases can easily be devised. For example two wedges (Fig. 14), *A* and *B*, are placed together. Should the line *ab* be shaded? Apparently it should because the two visible surfaces belong to different pieces, while if the drawing were of a single wedge *C*, it should not. This is unreasonable. Also the statement: "shade the lower

right hand quadrant of outside circles," etc., violates general practice, by which a semicircle is shaded, if at all.

Mr. Ives criticizes the proposed rule as rather vague, asking "if a ray of light comes from a point almost perpendicular to the paper . . . can the projection of that ray make a 45-deg. line, as at present?" Of course a ray of light exactly perpendicular to the paper projects upon it only as a point, but one not exactly perpendicular, by no matter how small an amount, has such a projected direction, which indicates in what direction the ray of light begins to incline.

The new rule requires shading as if light were nearly perpendicular to the paper, but not exactly so. It leans slightly towards the original or traditional position of the light upon the drawing.

There are a number of points in mechanical drawing in which practice varies and which could well be standardized by a committee for the purpose. Shading is only one of these points. I suggest that members consider what demand there is for uniformity, and at some near future time take steps to create the proper committee either to act alone or with other societies, as may prove wisest.

FIRE PROTECTION

At the Spring Meeting of the Society in Baltimore, the entire morning session on May 22 was given over to the presentation and discussion of Fire Protection, and the following papers were read: Baltimore High-Pressure Fire Service, by James B. Scott, and National Standard Hose Couplings and Hydrant Fittings for Public Fire Service, by F. M. Griswold, which were published in The Journal for March; The Life Hazard in Crowded Buildings Due to Inadequate Exits, by H. F. J. Porter, and The Protection of Main Belt Drives with Fire Retardant Partitions, by C. H. Smith, published in The Journal for May; Debarment of City Conflagrations, by Albert Blauvelt, and Allowable Heights and Areas for Factory Buildings, by Ira H. Woolson, published in The Journal for June. The discussion follows herewith.

DISCUSSION

W. H. Kenerson said that he had been unable, after reading Mr. Porter's paper and listening to the discussion, to understand just what the author advocated. The first paragraph of the paper and the recommendation for legislation in the last would lead one to suppose that he pinned his faith to ready exits; whereas the discussion emphasized the importance of the fire wall. While both of these were admirable in their place, they did not afford complete protection either singly or when taken together.

Referring to the statement that people do not want to remain in a burning building more than three minutes, the speaker said that he happened to be present at the start of a very quick fire where the people in the building were reluctant to stay at all. They got out of the building by jumping almost as quickly as they could run to the side walls. Even with adequate exits it was plainly evident that danger could not be eliminated. In

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buildings where operatives were working under crowded conditions some people would be burned or crushed before they could get out in case of a severe fire, even if the walls were open all the way round, owing to the furniture, machines, etc., being closely grouped. The panic following an incipient fire was often worse than the fire itself and did more damage. Moreover, in some of our large cities, the streets in the neighborhood of office buildings and factories were so narrow and would be so hemmed in by the crowds rushing toward the building in case of a fire that it was improbable that there would be room enough in the street to accommodate the operatives who were leaving. This was certainly true of some loft buildings in New York City.

Regarding the use of the fire wall, while it was of great value in certain cases and places, it was not altogether dependable. Was it not conceivable that fires could start on both sides of a partition at once? There were many conditions under which a fire would rapidly spread to both sides of a partition even if it did not start on both sides, as for example in a flash fire.

The author very properly said that sliding doors inside of partitions were dangerous; but what of swing doors? These should always open outward, but what was "outward" in a partition that must be used in both directions? Where communication was established between adjacent buildings even, it was inevitable that one of the doors would open the wrong way.

There was only one paragraph in the paper about preventive methods through the use of automatic apparatus in conjunction with other things for preventing fire at the start. It was unfortunate that this was not included in a paper of the general scope of the one under discussion.

He believed that it would be impossible to enforce the legislation recommended in the last paragraph of the paper to prevent architects from designing buildings which could be emptied in three minutes. Before construction such a matter was a question of opinion rather than fact. Moreover, operatives could not be prevented from crowding or becoming panic stricken in the event of a fire and it was doubtful under such circumstances whether many a properly designed building could be emptied in 3 minutes even if it were possible to enforce the first recommendation.

Henry Hess. I am neither an insurance man nor a sprinkler man. I have had some experience putting up factory buildings

and running the establishment afterwards. One of my most interesting experiences of that character I had in Germany where I was building a large tool works. The first thing I ran afoul of was the law. I bring this up particularly because Professor Kenerson has indicated that it was his belief that adequate legislation was absolutely impossible, if not as to securing it in the first place, then as to its later enforcement. Now that is a question of the will of the community. If the community really desires enforcement of law the community will see to such enforcement. Firewall partitions such as Mr. Porter advocates are very useful. In the case of the German factory partitions were installed in certain cases and were not insisted upon in others; but there was an insistence upon one other thing of possibly far greater importance. The authorities determined a central point for each floor area, considered the number of people at work in that area, and then insisted that there must be an adequate fireproof staircase within a certain distance of that central point. The size of the stairway was made to increase with the increase of that distance, which latter was not permitted to exceed a certain limit. Moreover, a stairway had to be provided at not merely one end, but at two ends at diagonal corners so that there was a possibility of reaching a stairway in two directions from a central point. The law does not permit overcrowding. Such conditions as obtain in New York City loft buildings would not be tolerated in the countries from which the people who run the industries in these lofts have come to us. Why should our communities grant them such permission here? Panic cannot be altogether guarded against in the construction of a building. Sprinklers do not constitute a full safeguard. In fact if you were to send down a douche of water upon an excitable woman when she smells smoke or sees fire you would most certainly not cool her down. Provide what safeguards you will, always keep the crowds down to a point where even panic stricken people cannot seriously jam.

Geo. I. Rockwood. As one interested in the general subject of fire protection, I have followed closely the fire statistics of the last seven or eight years as given out by the National Fire Protection Association and the Factory Mutual Fire Insurance Companies. I have also had experience with the manner in which automatic sprinklers operate to save human life, having

been responsible for the installation of many hundreds of thousands of sprinkler heads; so that with that experience back of me I want to say that no one so far as I know has really done more to convert the rather obstinate architectural profession, as well as the equally obstinate members of the profession of fire protection engineering, to the use of this very obvious device for getting operatives and others out of a burning room and into a place of safety than has Mr. Porter.

The way of the reformer is proverbially difficult, but it seems to me that those responsible for the design of loft buildings have been particularly slow in appreciating Mr. Porter's work. Very likely the reason for this will be found in Mr. Porter's scarcely concealed contempt for the automatic sprinkler as a life-saving device, but neither Mr. Porter nor anyone else has yet made any proper inquiry into the history of automatic sprinklers, considered solely from the point of view of their use as life savers. They have been regarded altogether as property savers, and are installed in buildings for that purpose. It is perfectly clear that every time a sprinkler operates successfully in a building containing human beings it is potentially a life saver. The question narrows down, therefore, to the effect of sprinklers in preventing panic conditions in buildings. Do they prevent panics or can they be made to prevent them? We need a little further light on this subject before we can dogmatize to advantage either way, but I feel confident that the solution of the problem of saving human life is a function equally of the use of Mr. Porter's centrally located incombustible partitions and the proper use of automatic sprinklers.

In the average case of a fire extinguished by automatic sprinklers three or four heads are all that open to effect the result. In the case of quick flash fires an entire roomful of sprinklers may open, seemingly at once, without any appreciable interval of time between the setting of the fire and the operation of the sprinklers. The question naturally arises, would such instant out-pouring of water be an advantage or a disadvantage to a room more or less crowded with operatives? No sane man would take the ground that he would rather be in such a room, under those conditions, without sprinklers. In a recent case where a flash fire occurred in the first floor of a three-story factory filled with people on every floor, a can of material in which gasolene was an ingredient took fire, and the curious fact resulted that although the room was

not a particularly large one, and there were many men at work in it, not a man got out of the room without getting wet. They said afterwards that there seemed to be no interval of time between the instant when the can flashed up and the subsequent out-pouring of water from all of the sprinkler heads in the room.

It might be thought that where a factory has a good deal of material out of which, say, straw hats, or lingerie, are made the rapidity with which the fire, once started, would propagate would insure the injury of everybody in the room. Such a view would fail entirely to take into account the fact that when the fire starts the heated gases almost instantly rise to the ceiling where they proceed to mushroom out and open the sprinkler heads one after another much faster than the fire can propagate itself in the material on the floor. This is not a matter of speculation; it is an observed fact.

There are classes of buildings in which there are so many concealed spaces in the wooden walls, wooden partitions and wooden floors, that a heavy fire may conceivably get strong headway in some concealed space before it showed itself. Under such circumstances the sprinklers operate at a disadvantage and merely act as a check to the spread of the flames until the arrival of the fire department. But even then they often make it possible for the firemen to carry their hose to the very center of the fire, and thus are the primary cause of its final extinguishment.

Mr. Porter would do well to add to his crusade in favor of a central fire resistant partition, with separate means of egress on opposite sides of it, a further demand for the installation of automatic sprinklers, and he will be surprised to see how much more quickly his original effort at reform will succeed.

HARRINGTON EMERSON. In making comparative investigations of American and foreign cities what strikes one most is the much lower fire loss in German cities than in American cities. The reason is that different ideals have been pursued. Our ideal is to get there immediately. In an international test of different fire companies at Berlin about 20 years ago it took the Americans 20 seconds to come out, couple up the hose and begin to play the water, while it took the Germans over 8 minutes to prepare to fight the fire. Nevertheless the fact remains that the fire loss in Germany is small compared to what it is in this country. It is not because they have buildings that cannot be burned, because recently in Hamburg a number of incendiary fires occurred with

severe losses. But the principle of the Germans is to prevent fire, not to fight it after it is started; while we have gone the limit in fighting fire after it is started. We are away behind the rest of the world in preventing fires before they start. Switzerland is a country of wooden houses yet the per capita fire loss there last year was only 2 per cent of the American per capita loss.

F. B. Gilbreth. There is no doubt but that standardization is the thing more than any other one thing that will reduce the number of fires; but let it be standardization for the prevention of fires rather than means for killing them after they are started. Fires are the product of ignorance. A very small portion of architects, and a still smaller portion of engineers, know how to build a building that will not burn up. There has been a paper written on the subject by Charles Whiting Baker, in which he adds not only to the statistics of dollar loss but also to the statistics of human loss. If I remember correctly there is a badly burned human being on the theoretical road from Chicago to New York every thousand feet, and every mile there is a man who has lost his life. This theoretical street consisted of a double row of six-story buildings, and these buildings burn up every year in the United States.

I have seen many of the big conflagrations in this country: Toronto, Rochester, Baltimore, San Francisco and Sioux City. A careful examination of all those ruins shows beyond any possibility of doubt that if we tried to build buildings that would burn up we really could not do a much better job. Reports of experiments carried on by Professor Woolson in New York City during the last ten years contain much valuable information upon this subject.

We face an entirely new situation today with the advent of concrete, which when made with the proper aggregates, such as trap rock and the right kind of sand, is of tremendous assistance in resisting the spread of fires. In fact, we are not depending on any of the old types of construction and fireproofing schemes for preventing the spread of fires. Let us have buildings, to begin with, that will not aid the spread of fire.

I suggest for the consideration of the Society an exhibit room to which engineers, architects and insurance companies may come and satisfy themselves that there is not a single thing in construction today that cannot be made better and quite as cheaply out of absolutely incombustible material.

JAMES B. SCOTT. Education, it has been said, should properly begin with one's grandparents, and undoubtedly the time to begin fighting a fire is before it begins. But granting that the "eugenics" of fire fighting have been properly observed, there will always remain the possibility of accident or incendiarism, giving rise to a hand-to-hand conflict with man's ancient enemy. The ships that can deliver more shells and heavier shells, in a given time and within a given area, and can begin delivery a few minutes earlier than the enemy, are usually awarded the victory in a modern naval engagement. The fire-fighting system which can deliver enough water, at a suitable pressure, just where it is needed, and can begin delivery in the fewest possible minutes after the discovery of a dangerous fire, is approaching the coveted 100 per cent efficiency in its limited field, as distinguished from the wider province of fire prevention.

H. F. J. PORTER. There is no need for closing the discussion on my paper, which simply points out the inadequacy and danger of the stairway. Such criticism as has been made has been answered in the discussion itself.

PRACTICAL OPERATION OF GAS ENGINES USING BLAST-FURNACE GAS AS FUEL

By Charles C. Sampson, Published in The Journal for May

ABSTRACT OF PAPER

The paper discusses the following features upon which the operation of gas engines using blast-furnace gas as fuel depends: present methods, improved apparatus, gas mains, suggested improvements in scrubber designs, gas regulation, protection from freezing, signal systems, protection from explosions, and the value of operation records.

Under the engines themselves are considered the operators, air starting system, water jacket cleaning, cylinder oil, engine oil and engine oil systems, ignition and prematuring.

DISCUSSION

Fred. H. Wagner. From reports received, I find that with practically the same character of apparatus, (*a*) dry dust cleaners, (*b*) some sort of static towers like the Czchokke or Steinbardt, and (*c*) the Theisen washer, the final cleaning varies between 15 cents and 62 cents per 100,000 cu. ft. of blast-furnace gas cleaned; this being based on $10 per 1,000,000 gal. of water and 1 cent per kw-hr. The great discrepancy in these final figures has led to the question as to why such discrepancies should exist. The answer is a difficult one to give; for instance, at one blast furnace the final cleaning based on 100,000 cu. ft. of gas costs 61 cents, at another 47 cents, at another 42 cents, at another 25 cents, at another 20 cents, at another 19 cents, and at another 15 cents.

Mr. Sampson mentioned that some new apparatus, which is along the line of mechanical disintegrators, claimed to use about 20 gal. of water per 1000 cu. ft. of gas for the whole cleaning process, and to operate on less power than the Theisen washers;

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also that with the present process from 90 to 100 gal. are used for the entire cleaning process.

At the last meeting of the West of Scotland Iron and Steel Institute, B. W. Head read a paper[1] giving the results of his visit on the European continent, for the purpose of examining blast-furnace conditions. After calling attention to the failure of the Scottish steel manufacturer to take advantage of the improved methods adopted in Germany, Belgium and France, he takes up the subject of washing blast-furnace gases for gas-engine purposes and points out the difference in the methods practised in the British Isles and those used on the Continent, mentioning especially the Feld vertical centrifugal washer for the cleaning of gas.

Besides the Theisen washer mentioned by Mr. Sampson, and the Feld washer, there is a third, the Schwarz. The last two are attracting a great deal of attention in Europe in connection with this process. They require less power than the Theisen washer, and the Feld requires considerably less power than the Schwarz.

At the blast furnaces in Donawitz, where 1,600,000 cu. ft. of blast-furnace gas is treated per hour, the total power with the Schwarz washers amounted to from 124 to 128 h.p. At the blast furnaces in Pompey, France, of exactly the same capacity, the Feld washers used from 50 to 55 h.p., the power given including the necessary power for exhausters. Unfortunately in my data on the Schwarz washers, I have not the power of the washer and the exhausters separate; however, for the Feld washers, the washer power amounted to from 15 to 20 h.p. and for the exhausters 35 h.p. This great difference in power requirements is due to the fact that the Feld washer throws absolutely no back pressure—the washer operating with an even gage on both the inlet and outlet, while the Schwarz washer throws a considerable back pressure.

In speaking of the quantity of water required for cleaning the gas, I would mention that two factors enter into this discussion: (*a*) being the cooling of the gas to a temperature which retains the heat units and at the same time reduces the volume of the gas to the smallest possible compass in order to avoid large gas-engine cylinders. The cooling of the gas is a thermal question, and

[1] The Journal, West of Scotland Iron & Steel Institute, vol. 19, Nos. 6 and 7, pp. 266 and 319.

the amount of water required is determined by the amount of water vapor which carries the heat contained in the gas. This amount of water would be necessary, no matter in what sort of washer the gas is cooled, as a certain number of heat units must be extracted, and the water cannot take up any more than its temperature will permit.

With a temperature of 500 deg. fahr. and treating 5,400,000 cu. ft. of gas per hour, with the gas coming from two furnaces, reducing this temperature to 86 deg. fahr. requires about 31 gal. of water per 1000 cu. ft. of gas. The cleaning of the gas after the water is cool, is done by the hot water from the cooling chambers, about one-quarter of the amount given above, or 7½ gal., being run into the washing chambers of the Feld washer. For this purpose the Feld washer is built in seven sections, the upper four acting as cooling chambers and the lower three as cleaning chambers. It is a known fact that if an impalpable powder be placed on a floor, and cold water is thrown on it, the water forms globules on the surface of the particles, but if hot water is thrown on the powder, it immediately mixes and forms a mud. This is the principle on which the Feld washer is operated. Each one of the sections of this washer contains a series of perforated truncated cones, the lower ends of the cones dipping into the water, and by the revolving of these cones, given a periphery speed of 1600 ft. per min., the water is carried up inside these cones and hurled out through the perforations in a finely divided spray.

Those conversant with dust washing will admit that the proper method to wash dust out of gas is to bring the gas into intimate contact with the smallest particles of water possible, and this is done in the Feld washer.

In a lead smelting furnace, where these Feld washers are in use, these washers recover six tons of dust containing from 80 to 100 per cent lead every 24 hours and entirely remove the lead particles, which formerly escaped into the atmosphere to the detriment of the surrounding vegetation.

In the blast-furnace plant at Pompey, France, where the Feld washers are also in use for cleaning blast-furnace gas for gas-engine purposes, I would state that prior to the use of the Feld washers, it was necessary to open up the valve chests on the engines about once every ten days and remove the accumulated dust; since the installation of the Feld system, it has become necessary to open up the valve chests only about once every three

months. These washers have been in continuous operation for about 30 months without one moment's shutdown for cleaning or repairs, the washers being self-cleaning, the water carrying the dust leaves the washer in the shape of a mud, which is easily handled by means of centrifugal pumps.

The aim of the modern engineer is to reduce the cost of operation and at the same time to secure better results. This has led to the Feld washer, and I would earnestly recommend anyone treating furnace gases for gas-engine purposes to investigate the Feld washer before purchasing other apparatus, as the first cost of the initial installation, as well as the ground space occupied is less than with the use of static towers.

A washer of the Feld type has just been placed in the works of the American Smelting and Refining Company at Maurer, N. J., for the purpose of removing the last traces of gold, silver, lead and silenium from the gas which comes from the mud cupel furnaces.

In order to clean 100,000 cu. ft. of blast-furnace gas for gas-engine purpose, or so that the final gas does not contain more than 0.01 grains of dust per cu. ft. and to reduce the temperature from 500 deg. to 86 deg. fahr. would cost with the use of nine Steinbardt coolers with the necessary Theisen washers, less labor and exhauster power, 14½ cents; with nine Steinbardt coolers and Schwarz washers, 11 cents; and with three Feld primary and two Feld final washers, 5.2 cents. This is based on the cost of water at $10 per 1,000,000 gal. and power at 1 cent per kw-hr. in a plant capable of handling 5,100,000 cu. ft. of gas per hour.

The author did not desire to present a closure.—Editor.

FOREIGN REVIEW

BRIEF ABSTRACTS OF CURRENT ARTICLES IN FOREIGN PERIODICALS

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The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Review. Articles are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of exceptional merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

FOREIGN REVIEW

Particular attention is called this month to the beginning of an abstract of the work of Professor Alliévi on the theory of water hammer, which immediately upon its publication in the original attracted wide attention among hydraulic engineers in France, Germany and Switzerland. The abstract is made from a French translation because the original Italian publication is not available. It appears that the problem of water hammer in the modern hydraulic installations working with high heads and large masses of water, is seriously interesting the European engineers, if one may judge from the number of articles on this question. Thus, besides the Alliévi article, an abstract is also given in this issue of The Journal of an article of de-Sparre, and in an early issue there will appear an abstract of a report on the same subject by the French Commission on Turbines.

THIS MONTH'S ARTICLES

A. Magnan shows that valuable data for the construction of monoplanes may be derived from an examination of the "design" of birds, particularly of birds of prey, and also brings out the interesting fact that, with the exception of their lengths, the present day monoplanes, in their proportional dimensions, approach very closely the bird of prey. Gastambide and Levavasseur describe the construction and explain the principle of their aero-parachute, a flying machine which, with the engine stopped, would slowly drop to the ground like a parachute. Brief abstracts on the Joukowski supporting planes and Canovetti experiments on resistance of air to moving bodies are also to be found. The section Hydraulics is particularly interesting this month, there being, in addition to the above-mentioned articles of Alliévi and de-Sparre, reports of articles on turbine regulation and on axial flow pumps. In the section Mechanics are given articles on graphic determination of moments by a combination of the Nehls and funicular polygon methods, as well as a brief statement concerning the calculation of shafts having several bearings. A discussion of steam consumption of exhaust

steam and combined turbines by Roeder indicates, among other things, the possible use, in connection with that class of turbines, of graphically determined lines instead of curves determined experimentally, for guarantee purposes of live steam consumption. Other articles describe an apparatus for preheating feed-water by exhaust steam and the construction of a sectional boiler adapted to be used with lignite briquettes. Some test data as to centrifugal pumps, and a brief discussion as to their advantages and disadvantages as compared with reciprocating pumps is also given. In the section of Strength of Materials and Materials of Construction, Fremont explains the peculiar formation of uniform folds in metal tubes compressed to the point of collapsing, the other articles indicating the importance of the presence of nitrous compounds for the production of rusting of iron: an etching solution for determining defects in autogenously welded pieces, and data of compression tests of vulcanized fiber, hard rubber and metal for stuffing box packing.

Aeronautics

DATA FOR THE CONSTRUCTION OF AN IDEAL MONOPLANE TAKEN FROM CHARACTERISTICS OF BIRDS (*Données pour la construction d'un monoplan idéal tirées de charactéristiques des Oiseaux*, A. Magnan, *Comptes rendus de l'Académie des Sciences*, vol. 156, no. 23, p. 1746, June 9, 1913, 2½ pp., *t*). The author asserts that the mechanical characteristics of the flying apparatus of birds varies in accordance as they use habitually sailing, soaring or flapping flight. Birds of prey, preferably using soaring flight, have a large surface of wings, small motive plant represented by undersized pectoral muscles, wide span across the wings, fairly wide wings and long tails, while birds using flapping flight mainly, such as sparrows, pigeons, etc., have wings of small surface, powerful pectoral muscles, short span across the wings, wide wings and fairly long tails. The type of bird nearest approaching in its flight to the monoplane is the bird of prey, and the author investigates what would be the dimensions of a monoplane possessing the same characteristics as a bird of prey, assuming an entire proportionality of dimensions. The author has found the following relations for daylight birds of prey:

Ratio of surface of wings, in cm. sq., to the surface of the body $S = \sqrt[3]{P^2}$	23.2
Ratio of weight of wings, in gr., to the weight of the body P	197
Ratio of span across the wings, in cm., to length of body $l = \sqrt[3]{P}$	13.3
Ratio of width of wing in the middle, in cm., to length of body $l = \sqrt[3]{P}$	2.36
Ratio of length of tail, in cm., to length of body	2.60
Ratio of actual length of body to $l = \sqrt[3]{P}$	5.9

The author proceeds to show that an ideal monoplane corresponding in its characteristics to a bird of prey, and having a weight, in flight, of 500 kg. (1100 lb.), would have the following characteristics:

Wing surface	14.70 qm	157.3	sq. ft.
Weight of wings	98.5 kg	216.7	lb.
Span across the wings	10.5 m	34.4	ft.
Width of wing	1.87 m	6.13	ft.
Length of tail	2.06 m	6.75	ft.
Length of apparatus	4.67 m	15.3	ft.

This shows that the apparatus designed in accordance with the scheme evolved from a study of birds would be shorter than those used at present, but in other characteristics would approach the bird of prey type more closely than usually believed. This method facilitates the proportioning of a monoplane for a given weight, but, in the form given, applies only to machines designed to fly above ground (i. e., to the exclusion of flying boats).

Experiments on the Resistance of Air to Bodies Moving in It (*Expériences relatives à la résistance au mouvement des corps dans l'air*, Canovetti, *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, vol. 119, no. 5, p. 633, 2 pp., *c*). Brief report of the experiments on air resistance. The experimenter used a four-cycle carriage running on an inclined funicular railroad (while the latter was not in commercial operation), with a bamboo scaffold carrying different planes, from 2 to 8 qm. (21.5 to 86.1 sq. ft.) area, at speeds from 5 to over 17 m. (16.4 to over 55 ft.) per sec. It has been found that the resistance is not proportional to the square of the speed, but varies in accordance with the formula $0.4\ V + 0.03\ V^2$. The author of the report, M. Lecornu, criticizes the method used by Canovetti, and points out various possible sources of error, recognizing however the main advantage of the method of Canovetti, that it does not require elaborate apparatus.

Joukowski Supporting Plane Problems (Two articles: On Pressure Distribution Along Joukowski Planes, *Über die Druckverteilung längs Joukowskischer Tragflächen*, Otto Blumenthal, *Zeits. für Flugtechnik und Motorluftschiffahrt*, vol. 4, no. 10, p. 125, May 31, 1913; and Graphic Construction of Joukowski Supporting Planes, *Graphische Konstruktion Joukowskischer Tragflächen*, E. Trefftz, ibidem, p. 130). The first article contains a mathematical investigation of pressure distribution along Joukowski supporting planes, as well as a discussion of their characteristics. The author shows among other things that in this plane there is a powerful suction action along the upper surface of the plane which is the main element in the supporting effect of the plane, the pressure on the lower surface contributing to it only in a moderate degree. The second article contains a description of a method for constructing a Joukowski supporting plane graphically.

Aero-parachute (*Sur un Aéroparachute*, Levavasseur and Gastambide, *Comptes rendus des séances de l'Académie des Sciences*, vol. 156, no. 23, 1748, June 9, 1913, 3 pp., 4 figs., *d*). The apparatus described is an aero-

plane with variable surface and incidence which can fly on all descending trajectories acting as a parachute. It consists of two wings and a symmetrically placed body, the wings being of variable area, and consisting each of three parts: a fixed part of trapezoidal shape, say (2+2) : 2x5, or 7.5 qm (80.6 sq. ft.) area, and two movable parts, each formed of two group of shutters. The entire wing, developed, has the form of a semicircle, of radius 5 m (16.4 ft.), and area 37.5 qm (403.5 sq. ft.). These wings are articulated on a frame, and can take any desired position, from horizontal to vertical, the frame in its turn being articulated on the body of the machine which permits varying the angle of the body with respect to the wings from 0 to 90 deg. The manoeuvring with the four folding wheel sections as well as the variation of the angle of incidence and of V are independent of one another, but a special apparatus may make all these operations coördinated in view of producing parachute flight and

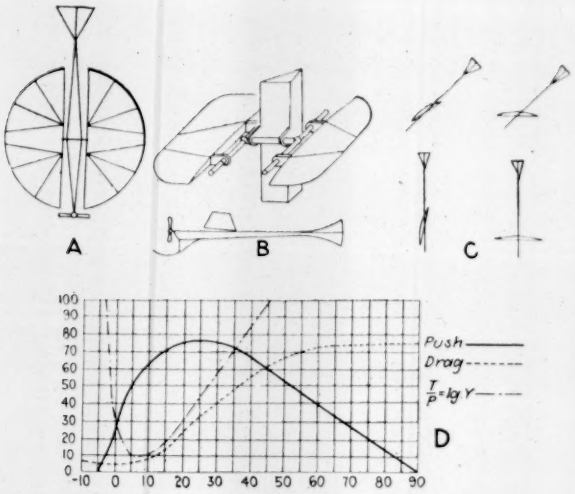


FIG. 1 AERO-PARACHUTE

parachute state. The apparatus has no rudder, and is steered by varying the folding sections of the wings (cp. Fig. 1, *A* and *B*).

In the following a study of the parachute state is presented, the variations of folding, incidence and V being coördinated, the incidence varying from 10 to 30 deg., surface of wings from 15 to 75 qm (161 to 806 sq. ft.), and V decreasing 4 deg. When the incidence varies from 30 to 90 deg., the surface of the wings remains constant at 75 qm (806 sq. ft.), and V decreases 20 deg. From the curves of drag and push (Fig. 1, *D*), with the area of surface only varying, the direction of the body being always that of the air stream lines, it is apparent that when the angle of incidence varies from 10 to 90 deg., the angle γ (angle between the resultant and vertical line) varies in the same sense, and takes practically the same values; it appears further that to each value of γ there correspond two

values of the ratio $\frac{t}{P}$, one for an angle of incidence less than the most favorable, and the other for one greater than the most favorable angle of incidence. There are apparently two ways of descending: one, volplaning, the incidence of the wings essentially that of the trajectory, this being the way of landing of the present aeroplanes; the other, parachuting, with the wings remaining horizontal, as in the aero-parachute proposed by the authors (cp. Fig. 1, *C*). The tests made by the authors have shown that the resultant intersects the chord of the wing at a point which varies as a function of the angle of incidence, the displacement of this point of intersection being favorable to the maintenance of stability for variations of angle of incidence from 10 to 90 deg., but dangerous for 10 to —5.5 deg.; in the latter case the stability is "differential," and is maintained by the rudder and balancing planes solely. Only angles of incidence from 10 to 90 deg. are to be used in the apparatus designed by the authors, additional stabilization being provided by locating the center of gravity of the apparatus on the prolongation of the resultant.

Hydraulics

THEORY OF WATER HAMMER (*Théorie du coup de bélier*, Professor L. Allievi, *Bulletin technique de la Suisse Romande*, vol. 39, no. 11, p. 121, June 10, 1913, 3 pp., serial article, to be continued, *tA*). A discussion of the theory of water hammer. In another investigation the author has shown that the variations of load along a water conduit travels with a speed a given by the formula:

$$\frac{1}{a^2} = \frac{\omega}{g}\left(\frac{1}{\epsilon} + \frac{1}{E}\cdot\frac{D}{e}\right) \quad \ldots\ldots [1]$$

where ω = the density of the liquid; ϵ = modulus of elasticity of the liquid; E = modulus of elasticity of the material of the walls of the conduit; D = diameter of the pipe, and e its thickness. If in formula [1] it be assumed that $\omega = 1000\ kg/m^3$ (62 lb. per cu. ft.) and $\epsilon = 2.07 \times 10^8\ ug/m^2$ (294,355 lb. per sq. in.) the following is obtained:

$$a = \frac{9900}{\sqrt{48.3 + K \cdot D : e}} \quad \ldots\ldots [1a]$$

where $K = 0.5$ for wrought iron and steel pipes, and $K = 1.0$ for cast iron pipes, the value of a varying between 600 and 700 m/sec. (1968 to 2296 ft. per sec.) for thin-walled pipes of large diameter, and 1200 to 1300 m/sec. (3936 to 4264 ft. per sec.) for thick-walled pipes of small diameter. The author formerly showed that the variable load y (in meters of water), and the variable velocity v in any section of a conduit of variable output, are expressed by the following equations:

$$y = y_o + F + f \text{ and } v = v_o - \frac{g}{a}(F - f) \quad \ldots\ldots [2]$$

t being time, and x the abscissa of the section under consideration measured along the axis of the conduit in a sense opposite to that of the velocity v, which is equivalent to saying that F represents a variable positive or negative load traveling in the direction $+x$ with a velocity a, while f represents a variable load traveling with the same velocity a in a direction $-x$.

With certain limit conditions introduced, equation [2] may be used for determining the values of F and f for each instant t and each abscissa x, so as to permit the numerical solution of all problems concerning variable flow of water in conduits. In particular, in the case of a conduit of length L fed at its upper end (abscissa $= L$) from a reservoir (constant level), and having at its lower end (abscissa $= O$) an outlet opening of which the cross-section may be varied by means of pipe closer, the values of the function f in any section of abscissa x and at any instant t, are always equal in magnitude but opposite in sign, to those of function F for the same abscissa, but for the instant preceding t by $2\ (L - x) : a$, which is the time required to travel twice, at velocity a, through the part of the conduit of length $L - x$, separating the section of abscissa x from the feed reservoir. This may be expressed by the equation:

$$f\left(t+\frac{x}{a}\right) = -F\left(t-\frac{x}{a}-\frac{2\,(L-x)}{a}\right) = -F\left(t+\frac{x}{a}-\frac{2L}{a}\right). \quad \ldots\ldots\ldots [3]$$

and may be interpreted by saying that the phenomenon develops as if each overload F traveling from the outlet orifice towards the reservoir (direction $+ x$) were reflected from the reservoir with a negative sign and sent back towards the pipe closer (direction $- x$). The values of perturbations (i. e. water hammer) in any section of abscissa x produced by moving the pipe closer, become therefore fully known as soon as the perturbations are determined in the section $x = o$, at the pipe closer, where

$$f(t) = -F\left(t-\frac{2L}{a}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [3a]$$

By means of the Bernoulli equation applied to the liquid jet blowing from the outlet opening, it is very easy to calculate series of numerical values of F for the abscissa $x = o$ and for instants t separated from one another by intervals $\frac{2L}{a}$ or, with F known, it becomes easy to calculate f for the same abscissa and time $\frac{2L}{a}$ seconds later. The author calls the interval $\frac{2L}{a}$ the *length of the phase*, and designates it by μ.

On the basis of the above stated fundamental conceptions, the author proceeds to establish a theory of water hammer, characterized among other things by the following three novel features: (*a*) systematic use in all formulas of *relative values* of variable quantities, i. e., the ratio of their absolute value to their initial value as a unit; (*b*) selection of velocity of discharge or rather its relative value, as the main variable instead of load, the new variable being obviously equal to the square root of the relative value of load; (*c*) selection in all cases of μ for unit of time, this permitting the reduction of all conduits to a common unit and leaving out of calculation the influence due to the length of conduit. By these means the laws governing the water hammer phenomena may be expressed as functions of only two parameters, one, which the author calls *conduit characteristic* and designates by ρ, completely defining the conduit when operating at uniform rate, and the other μ indicating the speed of operating the pipe more closely.

AXIAL FLOW PUMPS (*Über Axialpumpen*, Professor Wagenbach, *Zeits. für das gesamte Turbinenwesen*, vol. 10, nos. 16 and 17, pp. 241 and 272, 7 pp., 12 figs., *et*). Owing to lack of space, only the main conclusions of this very interesting investigation can here be given. The author shows that for each axial flow turbine there is a minimum quantity of water below which stable operation of the pump cannot be secured (lower limit of regulation). This limit of stability lies all the deeper as the ratio of peripheral speed to the head is greater. It is, therefore, of advantage to build axial flow pumps with large peripheral speeds, even though this may be done at a sacrifice of possible efficiency. The practical possibilities of axial flow pumps do not appear to be great. The simplicity of construction is an argument in their favor; their disadvantages lie in limited regulation, and low starting head. In addition to that there is another possible disadvantage, and that is higher friction and eddy losses. In radial flow pumps it has been established that the efficiency is the greater, the smaller in proportion to the useful output are the external surface of the runner and its peripheral speed. In axial flow pumps the surfaces under friction are hardly smaller than in radial flow pumps, while their average speed is much greater. It is therefore likely that the losses are also proportionally greater. Further tests and data are, however, necessary before it may be said that axial flow pumps are practically inapplicable.

REGULATION OF HYDRAULIC TURBINES (*Note sur la Régulation des turbines hydrauliques*, Professor Ch. Dekeyser, *Bulletin technique de l'Association des Ingénieurs sortis de l'École Polytechnique de Bruxelles*, vol. 11, Ser. 2, no. 6, p. 203, April 1913, 8 pp., *t*). Discussion of the principal cases of hydraulic turbine regulation. The author defines regulation as the totality of processes for insuring the operation of a turbine at constant angular speed, while certain conditions of operation vary. These variations in the conditions of operation may consist in variation in the volume of flow of water, of the head, and useful resistance. It is assumed that the purpose of the turbine plant is not affected by these variations, and that therefore the angular speed ω and the linear velocity of drag w are to remain constant. The following notation is used: W = useful power taken from the shaft; $\triangle$ = specific weight of water; Q = volume of water flowing across the turbine; ρ_1 = internal efficiency of the receiver; ρ_2 = mechanical efficiency; ρ_3 = coefficient depending on losses due to shocks which may occur at the entrance to the receiver (the author has elsewhere shown that with the turbine running under normal conditions at full load, $\rho_3 = 1$); H = the net head of water. The following relation exists between these quantities:

$$W = \triangle \rho_1 \rho_2 \rho_3 QH \quad \ldots\ldots [1]$$

On the other hand, if the moment of resistance on the driving shaft be designated by M, then $W = M\omega$. Hence:

$$\omega = \frac{\triangle \rho_1 \rho_2 \rho_3 QH}{M} \quad \ldots\ldots [2]$$

If it be made obligatory that the speed be constant for all conditions of operation, then *the quotient* $\frac{\triangle \rho_1 \rho_2 \rho_3 QH}{M}$ *must remain constant for all*

useful loads on the turbine shaft, this permitting the establishing of the following rules:

a If the moment of resistance M changes, either Q or H, or both these quantities, must be varied in such manner that the product QH varies proportionally to M;

b If either the volume of flow or the head happen to vary, M must be changed in such manner as to maintain constant the second member of equation [2].

The author considers further the influence on the degree of reaction by the variations in Q and H. The degree of reaction may be defined by either of the following equations:

$$\epsilon = \frac{p - p_e}{\triangle H} \quad \text{or} \quad \epsilon = 1 - \frac{v^2}{2gH}$$

where p is the internal pressure at the entrance to the receiver; p_e external pressure at the same point; v the absolute velocity at the same point also; kS cross section of the exit from the distributor; α angle of entrance of the stream lines into the receiver; $o = \frac{Q}{\sqrt{2gH}}$, the opening. Then:

$$\sqrt{1 - \epsilon} = \frac{o}{kS \sin \alpha} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [3]$$

and hence:

c In order that ϵ remain constant at all conditions of operations, $\frac{o}{kS \sin \alpha}$ must remain constant;

d If H stay constant, and section kS be reduced, the volume of flow will be reduced in proportion, and the degree of reaction ϵ remain constant;

e If H varies while kS remains constant, the volume of water is reduced in proportion to H, and ϵ is maintained constant.

The author considers three cases of varying conditions of operation, under which the speed must be maintained constant. First case: head is constant, and volume of water always sufficient to keep the turbine running at full load, the only factor likely to introduce disturbances being the variation in useful resistance. To insure the regulation of the turbine, it must be provided with a device that would keep the driving moment proportional to the moment of resistance, which may be done by maintaining H constant, and varying Q in proportion to the variation of the moment of resistance, which in its turn may be done by regulating the cross-section kS. The author shows that, as long as the gates used to reduce the section kS do not produce losses through sudden changes of cross section of kS, the mechanical efficiency is practically unaffected. The other theoretically possible method, viz., that of keeping the volume of flow constant, and varying the head, is shown to be much less convenient practically, as well as to require larger units than would be otherwise necessary.

The second case considered is where the volume of flow becomes at a certain moment insufficient to keep the turbine running at full load with the usual head. The useful output of the turbine has therefore to be reduced, the speed remaining constant. This is most often due to the variation of

level in the source of water, producing a general lowering of the hydraulic axis, and the author recommends shifting the gates so as to maintain the head H and the absolute velocity of entrance v constant, and at the same time to regulate the valves in such a manner as to change the section of entrance in proportion to the reduced magnitude of the volume of flow.

Third case: head H varies. This may be due either to accident or periodically acting causes, e. g. tides, the water level sometimes rising so high as to make the operation of the turbine impossible. As a rule, the volume of flow remains constant as long as the tide rises, or until the head water reaches the top of the weir, after which, with a further rise of water, the head water forms a supplementary resistance, and the volume of flow decreases. It is assumed here that while the head decreases, the volume of flow remains constant. With the outlet section of the distributor remaining constant, and the head, and consequently velocity v reduced, the turbine could not take care of that volume of flow, and as a result, as H decreases, Q must decrease as well, and as $Q \times H$ decrease, the output of the turbine must also rapidly decrease. Since Q decreases as $\sqrt{H}$, the output will decrease as $H^{3/2}$ while v decreases with H, which is self evident; since further w does not vary, shocks at the entrance are produced, and ρ_3 is reduced correspondingly, while ρ_1 is reduced because the constancy of speed $\xi = \frac{w}{\sqrt{2gH}}$ varies as $\sqrt{H}$. All these causes cumulatively reduce the output of the turbine with the change in available head of water, and, in order to secure the maximum of utilization of the fall, a larger unit has to be installed than is called for by the maximum volume of flow at the maximum head of water; in that case (i. e., with the turbine running with full admission at low heads, and partial admission at high heads), the output will decrease as H, and not as $H^{3/2}$ as shown above.

New Types of Centrifugal Pumps for Waterworks (*Neuere Kreiselpumpen für Wasserwerke*, Funke, *Die Fördertechnik*, vol. 6, no. 6, p. 126, June 1913, 4 pp., 10 figs., *d*). Description of some of the centrifugal water pumps built by Weise & Monski, of Halle a. S., Germany, and their characteristics. Only standard types are described.

On Water Hammer in Water Pipes Made Up of Sections of Different Diameters (*Sur les coups de bélier dans les conduites formées de sections de diamètres différents*, de Sparre, *Comptes rendus de l'Académie des Sciences*, vol. 156, no. 20, p. 1521, May 19, 1913, 2 pp., *mt*). With high water heads, pipes are often used whose diameter decreases with the increase of distance from the source of waterfall, and a consequent increase of pressure. At first sight it would appear that, should a water hammer occur, its maximum magnitude could not be beyond what it would have been if the entire conduit were made of pipe of the smallest diameter employed, i. e., at the place of maximum water velocity; the widening of the pipe in the upper part would be expected to decrease the kinetic energy of the water stored in the conduit, rather than the reverse. As the author shows, however, both of these assumptions, *for the case of sudden closure of the flow of water*, are entirely wrong. For a simple case of pipe consisting of three sections of gradually decreasing diameters, the author shows, that,

under certain elementary assumptions, the water hammer is nearly 50 per cent larger than it would have been, had the entire conduit consisted of the pipe of the smallest diameter. It appears further that in this case the water hammer occurs at the end of the sixth elementary period of oscillation, i. e., at the end of the first complete oscillation for the entire conduit. This establishes the mutual relation of the data obtained from the experiments of Allevard and the theory of Allièvi, showing why the former were in conformance with the latter only during the first oscillations. Those interested in the mathematical proof of the above are requested to communicate with the Editor.

Mechanics

GRAPHIC DETERMINATION OF MOMENTS OF INERTIA AND CENTRIFUGAL MOMENTS (*Zur zeichnerischen Ermittlung der Trägheitsmomente und Zentrifugalmomente*, Professor A. Denizot, *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 26, p. 1028, 1 p., 6 figs., *l*). The process recommended

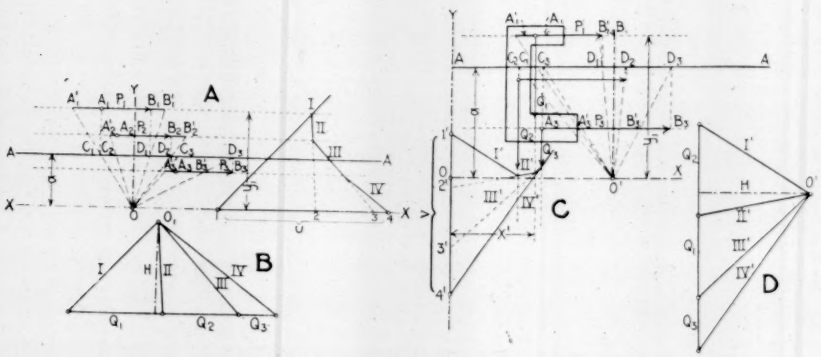


FIG. 2 GRAPHIC DETERMINATION OF MOMENTS OF INERTIA

by the author is a combination of the Nehls process with the application of a funicular polygon, and may be applied to the determination of moments of inertia and of centrifugal moments in any plane section. *Moments of inertia.* Figs. 2*A* and *B*, shows the application of the process to the case of three forces, P_1, P_2, P_3, with points of application A_1, A_2, A_3 with respect to a system of rectangular coördinates OXY. The moment of inertia $J_x = P_1y^2_1 + P_2y^2_2 + P_3y^2_3 = \Sigma Py^2$ is referred to the x axis to which the forces P are parallel. At an arbitrarily assumed distance a, a line AA parallel to XX is drawn, and the initial and final points A_1 and B_1 of the line P_1 are transformed in the same way as the points of limit of the cross-section in the Nehls process, viz., the initial and final points of P_1 are normally projected on the axis AA, to C_1 and D_1, and the points A'_1 and B'_1 determined as the points of intersection of the lines OC_1 and OD_1 respectively with A_1B_1. From the similarity of the triangles $A'_1OB'_1$ and C_1OD_1 it follows that

$$\overline{A'_1B'_1} : P_1 = y_1 : a \text{ and } P_1y_1 = A'_1B'_1a$$

$A'_1B'_1 = Q_1$, etc., multiplied by a, give the moments of the first order of the forces $P_1 \ldots$ To determine the moments of the second order, the line Q_1 is added to the lines Q_2 Q_3 (Fig. 2*B*), the apex of the polygon is arbitrarily selected, and the funicular polygon constructed; the extreme rays of the polygon I and IV cut then off on the axis XX the section u (1—4), which, multiplied by aH, gives the desired moment of inertia, which the author proceeds to prove. Should it be desired to apply this process to the case of plain sections, the latter are divided, as in the Cullmann and Mohr processes, into strips of which the center of gravity is next determined. Then through these centers of gravity or at a distance from them, parallel to the axis to which the moments are to be referred to, lines are drawn of which the length is proportional to the area of the respective strips, and proceeds as in the first case. As compared with the Cullmann process, this has the advantage of requiring no planimeter.

The centrifugal moment may be also easily determined, i.e., the expression $J_{xy} = P_1x_1y_1 + P_2x_2y_2 + P_3x_3y_3 = \Sigma Pxy$. To do this, the lines $A'_1B'_1 \ldots$ are rotated through 90 deg. about the points $A_1(x_1y_1) \ldots$, and the corresponding funicular polygon drawn, in which under certain conditions, the order of the lines Q_1, Q_2, Q_3, has to be changed. Next the funicular polygon I', II', III', IV' is constructed, and it is found that the extreme rays, I' and IV', cut off on the Y axis the line r (1' to 4'), which multiplied by aH, gives J_{xy}. This is so since

$$2\overline{3'} : \times = \frac{P_1y_1}{a} : H, \text{ or } P_1x_1y_1 = 2\overline{3'}aH,$$

hence

$$J_{xy} = \Sigma Pxy = (1'2' + 2\overline{3'} + \overline{34'}) = raH$$

Contribution to the Calculation of Shafts having Several Bearings (*Beitrag zur Berechnung mehrfach gelagerter Wellen*, H. Winkel, *Dinglers polytechnisches Journal*, vol. 328, nos. 23 and 27, pp. 353 and 424, June 7 and July 5, 1913, 7 pp. 10 figs., *mt.*). A shaft with n bearings may be considered as a continuous beam with $(n-2)$ statically undetermined conditions; i.e., in addition to the three conditions of equilibrium there are $(n-2)$ conditions of elasticity to be considered. The author states that although in civil engineering appropriate graphical processes for the calculation of continuous beams have been fully developed, these processes are described in works taking examples from fields unfamiliar to the mechanical engineer, and using scales with which he is not familiar. The present article attempts, therefore, to present the problem in a way convenient for the mechanical engineer. By starting from the Mohr formula, the author obtains the generalized form of the Clapeyron equation, from which, by means of the *T*-moments process, he develops a simple graphical method for the solution of the equation, for the case of a limited number of simple forces acting on the shaft. The article is not suitable for abstracting, and lack of space does not permit the complete reproduction of the mathematical treatment of the problem. For a brief discussion of single-throw crankshafts with double webs, supported on three bearings, see W. C. Unwin, *The Elements of Machine Design*, part 2, p. 173, London, 1912.

CONCERNING THE NOMENCLATURE OF SPECIFIC FLUID PRESSURES (*Über die Benennung der spezifischen Flüssigkeitsdrücke*, Dr.-Ing. R. Löwy, *Die Turbine*, vol. 9, no. 16, p. 281, May 20, 1913, 6 pp., 2 figs., *g*). A criticism of the nomenclature used by the Verein deutscher Ingenieure in the Specifications for Testing Fans and Air Compressors.

Steam Engineering

EXHAUST STEAM AND COMBINED TURBINES (*Über Abdampf- und Zweidruckturbinen*, Dr.-Ing. K. Röder, *Elektrotechnik und Maschinenbau*, vol. 31, no. 25, p. 526, June 22, 1913, 4 pp., 8 figs., *ct*). Abstract of a thesis pre-

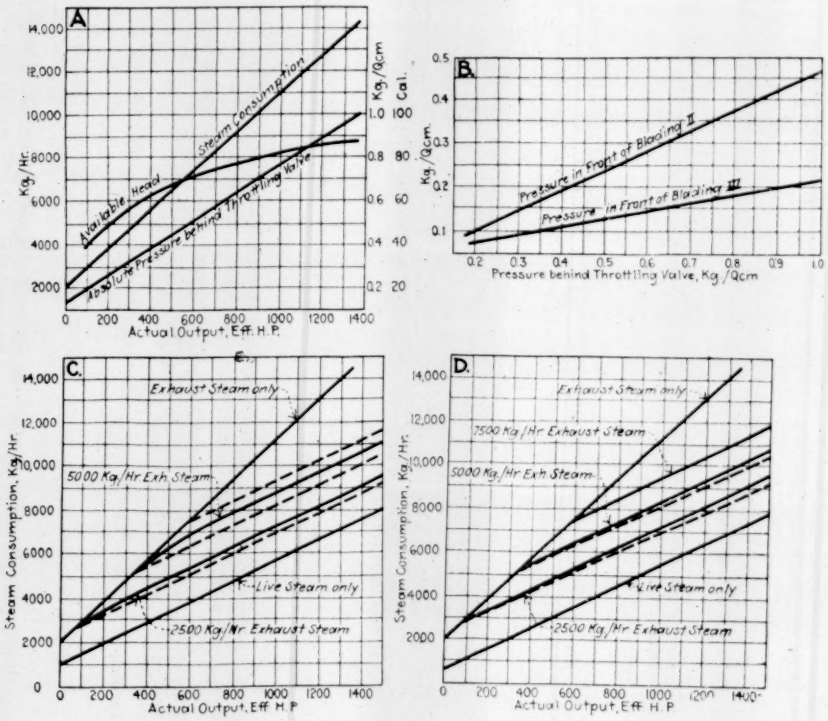


FIG. 3 CHARACTERISTIC CURVES OF EXHAUST STEAM AND COMBINED TURBINES

sented by the author to the Munich Technical High School, on the subject indicated by the title of the article. Among other things investigated by the author are steam consumption of exhaust steam and combined turbines. For the latter purpose a mixed steam Melms & Pfenninger turbine, having for the exhaust steam part two multistage reaction bladings, and an impulse wheel with two velocity stages to take care of the live steam. The turbine was rated at 1000 kw., but when supplied with 14,500 kg. (31,900 lb.) exhaust steam at 1.1 atmospheres absolute, with a vacuum in the exhaust connecting branch of 92 per cent, delivered only 900 kw. The

results of the investigation are presented in diagrams, of which Fig. 3A shows the weight of entering steam and absolute steam pressure in front of the first guide blade disk as a function of the effective output; there is an increase, in a straight line law, of the quantity of steam and initial steam pressure with increase of output, and direct proportionality between quantity of steam and initial steam pressure, as well as decrease of available head with the output. This is very much like what holds good for live steam condensing turbines, but Fig. 3B, showing steam pressure in front of various bladings as a function of the pressure in front of the first guide wheel, indicates not a law of proportionality, as in the case of live steam turbines, but a straight line increase of intermediate pressures with the increase of initial pressure.

The mixed steam turbine was investigated with respect to efficiency both for throttling regulation and regulation by varying the number of open nozzle groups. The rise of the efficiency curve referred to the state behind the throttling valve, with the decrease of load is not observable

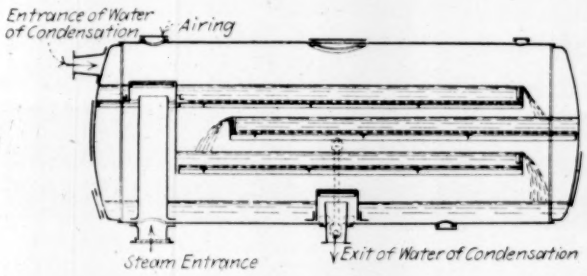


FIG. 4 FEEDWATER PREHEATER

in this case since the head in the high-pressure part varies but slightly, while the low-pressure part works even at full load with nearly the most favorable ratio of peripheral to steam velocity.

Tests for combined exhaust and live steam working have been made with both systems of regulation, their results being shown in Fig. 3C and D, the first for throttling, and the second for nozzle regulation, the exhaust steam admission in both cases being regulated by throttling. Through the points 2500 kg. (5500 lb.) and 5000 kg. (11,000 lb.) per hr., etc., of the curves (in this case straight lines) for exhaust steam operation, are drawn lines parallel to the curves of steam consumption for live steam only, and D shows that these straight lines correspond pretty well to the steam consumption curves found experimentally. These parallel lines can, therefore, be used for guarantee purposes instead of the actual steam consumption curves, thus materially simplifying the tests. In the case of throttling regulation, however, as indicated in C, this coincidence does not hold, and the actual steam consumption is larger than would be indicated by the parallel lines.

THE PLANT VIII/IX OF THE MINE CONSTANTIN THE GREAT (*Die Schachtanlage der Zeche Constantin der Grosse*, Ilgen and Dr. Wollenweber,

Glückauf, vol. 49, no. 21, p. 805, and no. 22, p. 845, 15 pp., 14 figs., *d*). Description of the mechanical equipment of the mine. In the utilization of the *waste steam* its use in the production of hot water is stated to be of greater advantage than in driving turbines. Provisions were therefore made to heat the entire feedwater up to the temperature of steam, or rather up to 100 deg. cent. (212 deg. fahr.). The apparatus shown in Fig. 4 is used, consisting of a cylindrical boiler with stepwise troughs. The feedwater enters from above, and gradually runs down through all the troughs, the steam, free from oil, entering from below and running in an opposite direction, and a special throttling valve preventing the possibility of live steam being admitted to the preheater. The hot water runs down to the feed pumps by gravity, and is used both for heating the buildings and for manufacturing purposes.

"Hall" Steam Pump (*Les pompes à vapeur "Hall,"* L. Béraud, *Revue industrielle*, vol. 44, no. 2087-22, p. 293, 3 pp., 7 figs., *d*). Description of

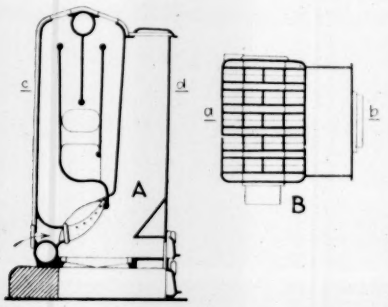


Fig. 5 Brico Sectional Boiler for Lignite Briquettes

long-stroke, slow-speed, steam-driven reciprocating pumps, their valve gear and lubricating equipment. These pumps are of French construction, and have been in use for several years, mainly in France and England.

Brico Boiler (*Der Bricokessel, Prd., Zeits. für Beleuchtungswesen*, vol. 19, no. 15, p. 195, May 30, 1913, 1 p., 3 figs., *dg*). A general discussion of the fuel problem for sectional boilers. Coke is altogether too expensive; all attempts to design an "ideal" sectional boiler that would use any fuel have failed, mainly owing to the conditions of operation of a sectional boiler, usually charged by the janitor once or twice a day, and left alone for the rest of the time. The new boiler described in this article has been designed for use with a particular fuel, lignite briquettes, and the author calls attention to the fact, that it is, like coke, an artificial fuel, and therefore more uniform in its composition and structure than native coal would be. The new boiler employs the half-gas system of heating. The fuel on the grate proper is only gasified by the primary fire, these gases being subsequently burnt immediately behind the grate with an addition of highly heated supplementary air. The author of the article states that by an ingenious system of air admission and mixing a complete combustion with a very hot flame is obtained. Fig. 5 shows the vertical and horizontal sec-

tions through the boiler. From the charging chute the fuel falls on to a grate where it is gasified. As shown in *A*, this gasification space is enclosed from above in special extensions which the author calls "air horns," the combustion chamber proper being above these extensions; the gases escape from the combustion chamber by a number of long and winding passages, and leave the plant through the rear end of the rearmost section, 3 mm (0.118 in.) draft being sufficient for normal operation. The supplementary air enters through the air extensions which are not cast in, but simply held, so that, in case of repairs, they could be easily removed. They are arranged in such manner that there is a thorough mixture between the secondary air and the fuel gases; in addition to that, soon after the furnace is started, the extensions become very hot, and preheat the air to a considerable degree.

Tests of a Brico boiler were made by the Saxony Association for the Inspection of Boilers, and have shown a utilization of fuel (lignite briquettes) of 80.98 and 83.93 per cent; the flue gases had temperatures of 182.79 and 181.71 deg. cent. (359.7 and 358.5 deg. fahr.) respectively, with contents of carbon dioxide of 13.87 and 13.12 per cent. The charging chute could take fuel for about eight hours of continuous operation, and required no attendance during that time.

Turbo-Pump Construction by C. H. Jaeger & Co., H. Mitter (*Zeits. des Vereines deutscher Ingenieure*, vol. 57, nos. 26 and 27, pp. 1005 and 1052, 18 pp., 72 figs. *d*). Description of the various types of centrifugal water pumps built by C. H. Jaeger & Co. Table 1 giving test data is of interest.

Efficiencies of 75 and 78 per cent have been reached, these representing, according to the author, the highest efficiencies obtained with pumps of those sizes. They are below the highest efficiencies attained with new reciprocating pumps of the best design, which, however, does not prove that reciprocating pumps are more advantageous. They are affected by the kind of water they handle in a higher degree than centrifugal pumps, and are more subject to loss of efficiency through having handled dirty water than centrifugal pumps of good design. The latter, in addition, require as a rule very little repairs, and the author quotes a case when a centrifugal pump after seven months' continuous work in a mine cost less than two dollars in repairs (caused by replacing a stuffing box packing). He points out further that in pump operation power costs are not inversely proportional to the efficiency of the pump, this being due to the fact that the high-speed electric motor is more economical than the slower speed motor required to drive a reciprocating pump. The saving in space, easier starting and higher reliability of the centrifugal pumps are also important factors in its favor.

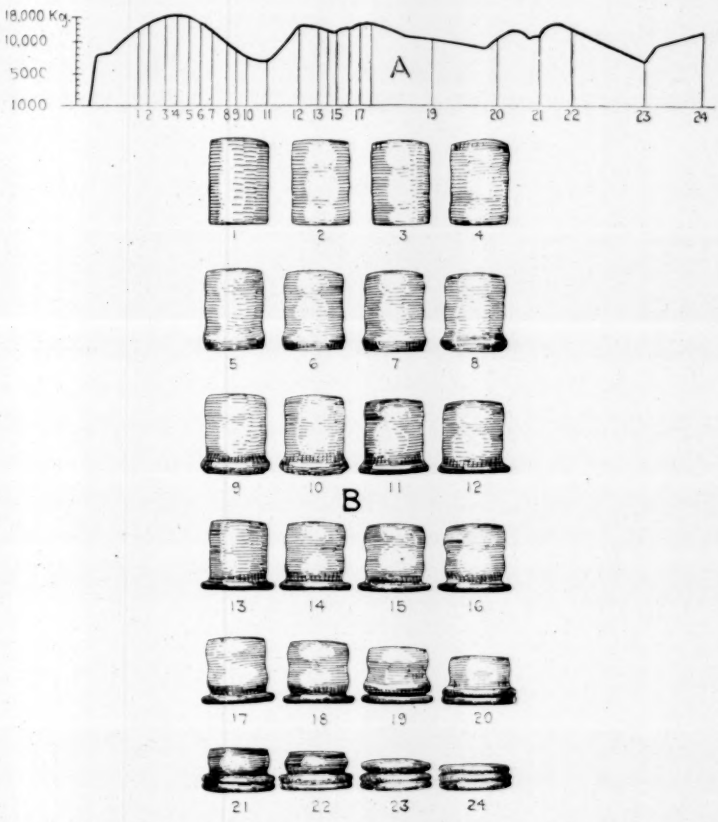
Strength of Materials and Materials of Construction

Distribution of Deformations in Stressed Metal (*Distribution des déformations dans les métaux soumis à des efforts*, Ch. Frémont, *La Technique moderne*, vol. 6, no. 11, p. 401, 4 pp., 35 figs., *e*.1). The author discusses the phenomenon of wrinkling of metal tubes subjected to compression. He calls attention to the well-known cases of formation in tubes

TABLE 1 DATA OF TESTS OF C. H. JAEGER & COMPANY'S CENTRIFUGAL PUMPS

Name of Plant	Mine König Ludwig	Mine Prussia II	Mine Hansa	Mine Augusta Victoria	Mine Queen Elisabeth	Mine Zollern
R.p.m.	1440	1475	1495	1470	1475	1475
Power supplied to motor, kw.	436.8	682.68	785.5	651.0	350.4	515
Efficiency of motor, per cent	94.0	94.0	95.0	94.0	93.5	95.0
Power delivered to pump, h.p.	557.9	871.8	1015.0	831.3	445	665
Total manometric head, m.	557.7	612.24	755.5	768.4	412.3	407
ft.	1829.25	2008.0	2478	2520	1352	1334
Volume of water, cbm/min.	3.41	4.97	4.63	3.78	3.65	5.66
cb.ft./min.	120.3	175.4	163.4	133.4	128.8	129.1
Output of pump in water lifted, h.p.	423	676.7	776.3	645	334.17	511
Total efficiency of plant (pump and motor) referred to the manometric head, per cent	71.2	73.0	72.7	72.9	70.2	73.0
Efficiency of pump referred to the manometric head, per cent	75.7	77.5	76.4	77.5	75.1	76.8
Guaranteed pump efficiency, per cent	72	73	72	70	72	....

compressed to the points of collapse, of regular concentric folds, and attempts to explain it from data obtained in his own experiments. After a series of tests with tubes of various thickness and materials, the author prepared 24 steel tubes, 50 mm (1.96 in.) in diameter, 80 mm (3.14 in.) long, with walls 2.5 mm (0.1 in.) thick, and completely crushed one of these specimen tubes, taking at the same time a record of the work of compression. In the tube were formed three concentric folds (Fig. 6*B*, 24), while

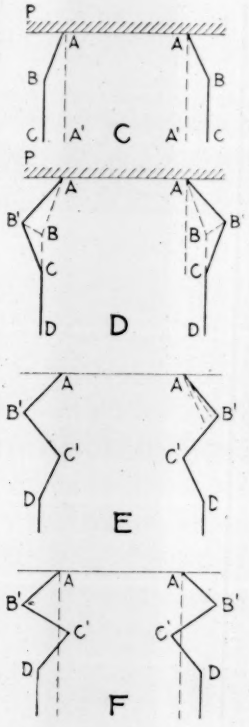


FIGS. 6.A AND 6*B* DEFORMATION OF METAL TUBES UNDER COMPRESSION

the diagram of work looked as shown in Fig. 6.A. The other 23 specimens were treated like the first, with the difference, however, that in each test the process of compression has been stopped at a different point, as shown by the respective numbers on the work of the compression diagram. The shapes of the tubes after compression are shown on Fig. 6*B*. In all these compression tests no guide frames or mandrels were used.

The author explains in the following manner the striking regularity of the circular folds formed on the tube by axial compression. Under the action of compression, the end of the tube changes its shape, at first elasti-

cally, and then permanently, the generating lines being forshortened, and the diameter tending to increase. Since, however, the ends of the tubes are kept in place by their friction against the plates of the press, the increase in diameter is not uniform throughout, and, as a result, a tendency is produced towards the formation at the ends of the tube of truncated cones. Fig. 6*C* shows the beginning of the formation of such a cone. The tube, of initial diameter *AA'*, under compression, spreads out, and its diameter, at a certain distance from the plate of the press *P*, increases to *BB*, while



FIGS. 6*C*, 6*D*, 6*E* AND 6*F* DEFORMATION OF METAL TUBES UNDER COMPRESSION

the friction at *P* keeps there the original diameter *AA'* unvaried. During the change of shape of the tube, the direction of pressure is no longer on lines parallel to the longitudinal axis of the tube, but along the inclined line *AB*, the generating line of the truncated cone. With the pressure continued, the height of the cone decreases, not because the generating lines foreshorten, however, but because they incline more than before; the diameter of *BB* increases still more, and finally becomes *B'B'*, and the inclined direction of the stress produces in the originally cylindrical parts *BC*, a corresponding deformation to *B'C'* (strictly speaking, *BC* ceases to be cylindrical from the moment of the diameter of *BB* departing from its original magnitude *AA'*.—EDITOR). After the two opposite truncated cones shown in Fig. 6*D* have been formed, the pressure continuing in the direction of

the generating lines, the trunks of the cones decrease in height, the common bases $B'B'$ expand, and assume the form of a circular fold (Cp. Fig. 6*B*, 7 to 13). The base AA' subject to friction againsr the press plate, cannot change its shape, but the base CC of the other cone can do so more easily and, accordingly, the pressure acting all the time along the generating lines tends to push *towards the interior* of the tube the third section of the tube $C'D$, which becomes also a truncated cone first, and part of a second circular fold later (Cp. Fig. 6*E* and *F*, and in *B*, nos. 15 to 20). The deformation is therefore due to compression initially, and to bending later on. The author shows that all deviations from the process described are due to accidental causes, such as the shape of the pipe, irregularities in the constitution of the material, etc.

A New Chemical Cause of the Rusting of Iron (*Eine neue chemische Ursache des Rostens von Eisen*, Dr. W. Vaubel, *Chemiker-Zeitung*, vol. 37, no. 69, p. 693, June 10, 1913, 1 p., *t*). The author draws attention to the important part of *nitrous compounds*, in particular, *ammonium nitrate*, in the production of *rusting of iron*. He further shows not only that ammonium nitrate is widely present in ground waters, but that it may be formed from the nitrous compounds in the air through the intermediate action of oxides and hydroxides of iron.

A New Process for Detecting Cracks, Untight Places and Slag Inclusions in Autogenously Welded Pieces (*Ein neues Verfahren, um Risse, undichte Stellen und Schlackeneingüsse in autogen geschweissten Stücken nachzuweisen*, A. Stadler, *Die Turbine*, vol. 9, no. 18, p. 324, June 20, 1913, 1 p., 1 fig., *pd*). The author recommends, for detecting defects in autogenously welded pieces, the use of an etching solution consisting of 100 parts (by weight) of water, 5 parts of chemically pure nitric acid, and 5 parts of potassium chlorate. The burnt iron is shown by an increase in the size of crystals and their dark color; cracks appear as dark lines. Slag inclusions are not affected by the etching solution, and come out prominently through their glassy appearance. The etching solution gives the metal a light gray color, on which all irregularities come out very well.

Compression Tests of Vulcanized Fiber, Hard Rubber and Metal for Stuffing Box Packing at Ordinary and Higher Temperatures (*Druckversuche mit Vulkanfiber, Hartgummi und Metal für Stopfbüchsenpackungen bei gewöhnlicher und höherer Temperatur*, R. Baumann, *Zeits. des Vereines deutscher Ingenieure*, vol. 57, no. 23, p. 907, June 7, 1913, 4 pp., 12 figs., *c*). Data of tests made at the Laboratory for Testing Materials at the Royal Technical High School, Stuttgart, Germany. It has been found that the compressive strength of all the above materials rapidly decreases with the increase in temperature. The temperature at which a material is tested for its compressive strength ought, therefore, to be indicated. When vulcanized fiber takes up moisture, it rapidly expands, but not uniformly in all directions. Its hardness and compressive strength depend also materially on the direction in which the stress is applied. Hard rubber, when under greater stresses, is apt to flow, with a tendency towards the formation of cracks, simultaneous with an increase in cross-section. By "metal" the author means an alloy of lead and antimony, with about 30 per cent of the latter.

NECROLOGY

WILLIAM M. DOUGLASS

William M. Douglass, treasurer of the Globe Real Estate Company of Allentown, Pa., died in that city on March 23, 1913. Mr. Douglass, who was one of the early members of the Society, began his professional career in 1878 in the steel mill of the Gautier Steel Company, Johnstown, Pa., where he had partial charge of erecting engines and trains. In the following year he was given the management of the mill and during the subsequent years of his connection with it built one train and rebuilt two others, mainly from his own plans. In 1883 he began the plans for the Hartman Steel Company at Beaver Falls, erecting all the roll trains, engines, boilers, etc., partly from his own designs. In September of the same year he was made superintendent of the entire plant.

In 1884 Mr. Douglass removed to Allentown, to become general superintendent of the Iowa Barb Wire Company, continuing in this capacity until 1894 when he became general superintendent of the Consolidated Steel & Wire Company. In 1899 he became superintendent of the American Steel & Wire Company of the city, advancing in 1904 to the position of assistant to the general superintendent. He retired from the rolling mill field in 1906, and in 1911 entered the business in which he was engaged at the time of his death.

SAMUEL LYON MOYER

Samuel Lyon Moyer, first vice-president of The Lunkenheimer Company of Cincinnati, Ohio, died at his home in that city on May 3, 1913. Mr. Moyer was born in Cincinnati on August 17, 1874, and was educated in the public schools. He had been connected with the company since 1890, almost from the time of the completion of his school work, working his way up to the management from a small beginning, entirely by his industry and rare ability.

He was a deep student of men and affairs, possessing clear

vision and remarkable foresight, and contributed at every opportunity of his time, money and intellect for the growth and advancement of his native city. While not an active engineer he was well informed and keenly interested in engineering and scientific tests of the day, particularly in the line of progress and development.

Mr. Moyer was a member of the National Metal Trades Association, and a number of social and business clubs.

JOHN BRADFORD PERKINS

John Bradford Perkins was born in Boston, August 2, 1869. He was educated in the public schools of Lowell, Mass., and served an apprenticeship with the General Electric Company of Lynn, Mass., and the Lowell Machine Company of Lowell. Upon its completion he entered the employ of Hollingsworth & Vose, at Walpole, Mass., resigning to enter the Crosby Steam Gage & Valve Company. In 1905 he became the New England manager for the Hewes & Phillips Iron Works, Newark, N. J., manufacturers of Corliss engines. The John B. Perkins Company, a firm which engaged in the installation of complete power plants, was organized by him the following year, Mr. Perkins serving as its president up to the time of his death on January 19, 1913. In this capacity he made many important installations, notably the Fitchburg Yarn Company, with its record for economical operations, the Windham Manufacturing Company, Willimantic, Conn., the Burgess Mills, Pawtucket, R. I., and the Potomsko Mills, Fall River, Mass. He also designed and put on the market the "Bradford" valves.

Mr. Perkins was a member of the Engineers' Club of Boston, the New England Street Railway Club, the National Association of Stationary Engineers, the Nayassett Club of Springfield, the Quequechan Club of Fall River, and the Deerfield Club of Manchester, Vt.

FRANCIS M. RITES

Francis M. Rites was born at Petersburg, Ill., on July 20, 1858, and received his preparatory education at Chester, N. Y. He entered Sibley College, Cornell, in 1877, graduating with the degree of B.M.E. in 1881.

Directly after leaving college, he entered the employ of the Lehigh & Hudson River Railroad for a short time, and in 1883 became identified with the Westinghouse Machine Company.

During his connection with them he made many notable developments and inventions, among them a system of high-speed compressors, a new system of explosive engine control and distribution, and the inertia governor, for which he is best known. He died at his home in Slaterville, N. Y., on May 2, 1913.

ACCESSIONS TO THE LIBRARY

WITH COMMENTS BY THE LIBRARIAN

This list includes only accessions to the library of this Society. Lists of accessions to the libraries of the A. I. E. E. and A. I. M. E. can be secured on request from Calvin W. Rice, Secretary, Am. Soc. M. E.

ADDRESS OF C. C. CHAMBERLAIN TO THE SPECIAL COMMITTEE OF THE GERMAN REICHSTAG (in English and German). Gift of author.

AMERICAN RAILWAY ASSOCIATION. Proceedings of session held in New York City, May 21, 1913. Gift of association.

ASSOCIATION OF RAILWAY ELECTRICAL ENGINEERS. Proceedings, vols 1-4. *Chicago, 1908-1911.* Gift of association.

BEITRÄGE ZUR GESCHICHTE DER TECHNIK UND INDUSTRIE, HERAUSGEGEBEN VON CONRAD MATSCHOSS. Vols 2 and 3. *Berlin, 1910, 1911.*

CALIFORNIA MINERS' ASSOCIATION. Annual, 1912. *San Francisco, 1912.* Gift of association.

CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING. 6th Annual Report of the President, 1911. *New York, 1911.*

CARNEGIE INSTITUTION OF WASHINGTON. Scope and organization, issued on the occasion of the 10th anniversary, December 14, 1911.

CHICAGO BOARD OF SUPERVISING ENGINEERS CHICAGO TRACTION. 4th Annual Report, 1911. *Chicago, 1912.* Gift of Bion J. Arnold.

CHRONOLOGY OF AVIATION, Hudson Maxim and W. J. Hammer. Reprinted from World Almanac, 1911.

CINCINNATI WATERWORKS DEPARTMENT. Annual Report, 1912. Gift of the department.

COLUMBIA UNIVERSITY, ERNEST KEMPTON ADAMS FUND FOR PHYSICAL RESEARCH. Publication nos. 4 and 6. *New York, 1912.* Gift of the university.

CONGRESO CIENTIFICO INGENIERIA (1° Pan-Americano). Vol. 2. *Santiago de Chile, 1912.* Gift of the congress.

ENGINEERING SOCIETY OF YORK, PA. Proceedings, 1913. *York, 1913.* Gift of the society.

ENGINEERING TABLES AND DATA, W. W. F. Pullen. ed. 3. *Manchester, England.*

A useful compilation, which, although containing only 68 pages, gives much information which engineers need. The steam table has been thoroughly revised, and represents the result of the most recent researches.

LES ETATS-UNIS D'AMÉRIQUE, D'Estournelles de Constant. *Paris, 1913.* Gift of American Association for International Conciliation.

EXPERIMENTS IN THE PRESERVATIVE TREATMENT OF RED-OAK AND HARD MAPLE CROSSTIES, F. M. Bond. U. S. Dept. of Agriculture, Forest Service Bull. 126. *Washington, 1913.* Gift of author.

DAS FÖRDERGERÜST SEINE ENTWICKELUNG, BERECHNUNG UND KONSTRUKTION. Th. Möhrle. *Breslau.* Gift of Hunt Memorial Fund.

GOOD PAVEMENTS ON STREETS NOT GUARANTEES ON PAPER, J. W. Howard. *New York, 1911.* Gift of author.

HANDBOOK OF NATURAL GAS, Henry P. Westcott. *Erie, 1913.*

HANDBUCH DER FEUERUNGSTECHNIK UND DES DAMPFKESSELBETRIEBES, Georg Herberg. *Berlin, 1913.*

INTERNATIONAL RAILROAD MASTER BLACKSMITHS' ASSOCIATION. Proceedings of the 19th Annual Convention. *Toledo, 1911.* Gift of the association.

JEROME PARK FILTERS, REPORT OF THE ADVISORY COMMISSION OF ENGINEERS. Part I: Relating to Filtration of Croton Water. Gift of N. S. Hill, Jr.

KANSAS ENGINEERING SOCIETY. Transactions 1912. *1912.* Gift of the society.

KOSTENBERECHNUNGEN FÜR INGENIEURBAUTEN, Georg Osthoff and Baurat Scheck. ed. 7. *Leipzig, 1913.*

LOHNTARIF FÜR AKKORDBESTIMMUNGEN IM MASCHINENBAU, H. Haeder. Vol. 2: Kalkulieren der Maschinenteile. *Wiesbaden, 1913.*

LOUISVILLE WATER COMPANY. 55th Annual Report. *Louisville, 1912.* Gift of the company.

METALLOGRAPHIE, W. *Guertler.* vol. 2, part 1. *Berlin, 1913.*

NATIONAL ASSOCIATION OF STATE UNIVERSITIES IN THE UNITED STATES OF AMERICA. Transactions and Proceedings, 1910. *Hamilton, O., 1910.*

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NEW YORK STATE LIBRARY. Handbook for readers concerning the New York State Library and its home in the State Educational Building. *Albany, 1913.* Gift of the department.

OERLIKON LÖTSCHBERG ELECTRIC LOCOMOTIVE, NO. 121, 2000 B.H.P. Reprinted from "The Engineer," February 2, 9, 1912. Gift of Maschinenfabrik Oerlikon, Zürich.

OHIO ELECTRIC LIGHT ASSOCIATION. Proceedings of the 17th Annual Convention. *1911.*

PAVEMENT GUARANTEES, THEIR USE AND ABUSE, J. W. Howard. *New York.* Gift of author.

PENNSYLVANIA SOCIETY YEAR BOOK, 1910. *New York, 1910.*

PETROL AIR GAS, THE NEW FORM OF ILLUMINANT, C. A. M. Smith. *London.*

PRACTICAL ALTERNATING CURRENTS AND ALTERNATING CURRENT TESTING, C. F. Smith. ed. 5. *Manchester, England.*

That a textbook for college students has reached a fifth edition is a guarantee that it is well liked and well adapted to its purpose.

PROGRESS REPORT ON WOOD-PAVING EXPERIMENTS IN MINNEAPOLIS, F. M. Bond. U. S. Dept. of Agriculture, Forestry Service, circular 194. *Washington, 1912.* Gift of the author.

SCIENTIFIC SALESMANSHIP, C. H. Pierce. *New York, 1906.*

SERVICE AND METER INSTALLATION RULES, NEW YORK EDISON COMPANY, June 1913. *New York, 1913.* Gift of C. W. Rice.

SOME TESTS TO DETERMINE THE EFFECT UPON ABSORPTION AND PENETRATION OF MIXING TAR WITH CREOSOTE, F. M. Bond. Gift of the author.

STEAM POWER PLANT ENGINEERING. G. F. Gebhardt. ed. 4. *New York, 1913.*

This edition has been largely rewritten and many illustrations added. There are particularly full data on power costs.

SWEDISH ENGINEERS' SOCIETY OF CHICAGO. Constitution and By-Laws and List of Members, 1913. Gift of the society.

TECHNOGRAPH. vol. 13, 16. *Urbana, 1899, 1902.* Gift of University of Illinois.

UNIVERSITY OF CHATTANOOGA. Catalogue 1907-1908, 1911-1912, 1912-1913. *Chattanooga.*

EXCHANGES

ECOLE D'APPLICATION DU GÉNIE MARITIME. COURS DE MACHINES À VAPEUR. vol. 3. *Paris, 1912.*

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TRADE CATALOGUES

FAIRBANKS COMPANY, *New York, N. Y.* Catalog B 30, Makuteban roller bearings and hangers, 31 pp.

GOLDSCHMIDT THERMIT COMPANY, *New York, N. Y.* Thermit marine repairs, 1913.

JOHNS-MANVILLE, H. W. & COMPANY, *Cleveland, O.* J.-M. power expert, June 1913.

LIDGERWOOD MANUFACTURING COMPANY, *New York, N. Y.* Bull. 12, Lidgerwood electric hoists, 20 pp.

RAILWAY CAR DOOR COMPANY, *Chicago, Ill.* Reasons why freight car doors should be placed inside of the car instead of outside, 7 pp.

UNITED ENGINEERING SOCIETY

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE. Year Book 1912. *Washington, 1913.* Gift of the endowment.

NEBRASKA STATE RAILWAY COMMISSION. 5th Annual Report. *Lincoln, 1912.* Gift of the commission.

PATENTE JAHRES-KATALOG, 24th year 1912. *Brugg, 1913.*

EMPLOYMENT BULLETIN

The Society considers it a special obligation and pleasant duty to be the medium of securing positions for its members. The Secretary gives this his personal attention and is pleased to receive requests both for positions and for men. Notices are not repeated except upon special request. Names and records, however, are kept on the current office list three months, and if desired must be renewed at the end of such period. Copy for the Bulletin must be in hand before the 12th of the month. The published list of "men available" is made up from members of the Society. Further information will be sent upon application.

POSITIONS AVAILABLE

506 Superintendent of large experience in automobile and Diesel engine construction. Location Middle West.

608 Technical graduate with one or two years' experience, wanted as instructor in mechanical engineering. Location Western Pennsylvania.

702 Technical expert wanted in purchasing department of a large works near New York, making high-grade light metal products, to assist in selecting, buying and inspecting the varied materials used. Should be good metallurgist, fair chemist and familiar with fuels. Apply through the Society, giving age, education, experience, reference and approximate salary required.

703 Wanted by Ohio concern, mechanical draftsman experienced in the design of large steam or gas engines. State experience and salary expected. Apply through the Society.

704 Engineer, capable of taking charge of general construction work around various plants, looking after construction of new buildings, remodeling, mapping out changes, betterments for power, fuel, crude oil and producer gas furnaces, installation of new machinery, rearranging old machinery to effect economies, etc. Location Middle West.

705 Instructor to handle first year mechanical drawing work and to teach civil engineering subjects; if possible one who has had practical experience and contact with affairs along structural engineering lines, as well as a year's teaching experience. College or technical school graduate with initiative. Location Philadelphia. Salary about $1200.

706 Partner to assist in development of a new steam turbine, of the compound impulse multi-stage type, capable of good efficiency in all sizes from 1 h.p. upward, and now ready for commercial development. A high-grade successful salesman of steam turbines desired who can furnish necessary capital.

707 A large manufacturing company located within fifty miles of New York, seeks the services of an experienced mechanical and electrical engineer. Position is technical rather than administrative. Duties: to study the plant, equipment, processes and products, to report those found defective, inefficient or wasteful, and to make recommendation for increasing the economy and efficiency of production, and improving the quality of the product which comprises a wide

range of metallic articles. Apply through the Society, stating age, training, experience, references and salary expected.

708 Wanted foundry superintendent; thoroughly high-class man able to take entire charge of foundry employing about 140 men on high-grade machine tool work. Must thoroughly understand modern methods of molding with machines, the mixing of irons and be an executive of highest order. Foundry is equipped with the most modern appliances and is comparatively new. Only a man of high ability desired, technical graduate preferred. Apply through the Society. Location Middle West.

709 Partner desired by consulting and advisory engineer, engaged principally along lines of mechanical refrigeration, cold storage and ice-making plants. Experience in the ice-machinery line immaterial, but some investment in the business expected.

712 Experienced heating and ventilating engineer for New York concern. Apply through the Society.

714 Editor, aggressive, energetic young man of technical training, familiar with publishing business. Salary from $25 to $40 a week depending upon experience. Location New York.

716 Mechanical draftsman, Sandy Hook Proving Ground, $100 per month. One capable of filling position temporarily until an eligible can be supplied by the U. S. Civil Service Commission. Applicant should have a good mechanical education and at least two years' practical drafting experience. Replies should state fully both training, experience and age. Examination will be held on August 6, in New York City, for the purpose of filling this position permanently.

718 Teaching position open with large eastern engineering school. A mechanical engineering graduate wanted, preferably with some experience in practical work. Appointment will be made early in September. Apply through Society.

719 Young engineer on sales work. Location at first in New York City at $15 to $20 per week. Later upon making good to go to Havana.

720 A well-known manufacturer of high-grade steam specialties wants manager for long established branch office. Must have thorough knowledge of power plant equipment and be a salesman of tried and proven ability. Complete history of previous work and references that will stand rigid investigation are necessary. Apply through Society.

MEN AVAILABLE

175 Junior member, 30 years of age, at present employed, technical education, 10 years' experience in design, construction, operation, maintenance and reorganization of mill, factory, and other manufacturing properties. Wide experience in the superintendance of central power stations, factory extension, mill and reinforced-concrete construction work.

176 Aggressive, broad gage man with initiative, exceptional ability, acquired by wide experience in mechanical and electrical manufacturing and sales, energy and tact. Now sales manager; has worked from drafting room to superintendent in bronze, iron and steel foundry and machine shop; desires to connect with reputable concern where first-class man will have opportunity to produce maximum results. Familiar with government business and requirements. Age 36.

177 Technical graduate, Junior member, age 30, eight years' experience in designing, estimating costs, construction and inspecting in car and locomotive work, contractors' equipment, heating and ventilating. In charge of men and competent to manage field and office operations. Now open for position as branch manager, engineer-in-charge, or salesman. Personal interview desired. Clean references from previous connections.

178 Student member, age 27, graduate Cornell 1913, seven years' experience as machinist (prior to and during summers of college course), wishes to locate in the East or South.

179 Superintendent or chief engineer, graduate in mechanical and electrical engineering degree of M.E. and two years in naval architecture at M. I. T. Experienced as designer, superintendent of shop and erecting. Familiar with latest practice in machine shop and shop construction, and scientific management of men in factories. Desires position with opportunity to advance.

180 Member, technical graduate, B.S. and M.E., at present employed, desires to make a change. Experience in power plants, pipe and electrical lines, lighting, heating and ventilation. Familiar with design, preparation of plans and specifications, supervision of construction, and operation after completion. Salary $200 to $250 per month, depending on location, opportunity, etc.

181 Member with broad varied experience in manufacturing lines desires to make a new connection September 1, preferably with a medium sized plant, to look after the manufacturing end. Can invest a small amount of capital if desired.

182 Mechanical engineer, age 29, with liberal experience in the design, construction and operation of power plants, industrial plants and conveying and transmission machinery, good organizer and executive, capable of handling efficiently large numbers of men, wants position as principal or assistant engineer on the construction of plant, or with consulting engineer, or as plant superintendent or assistant with manufacturing concern. Location no object, but Middle or Far West preferred.

183 Junior member, age 27, technical graduate in mechanical engineering, experienced in detailing and estimating on steel plate work, wishes to secure position in the estimating and sales department of a company doing plate and boiler work.

184 Construction superintendent, desires position with some future possibilities. Thirteen years' practical experience in construction work, design and operation of power stations, power distribution, general construction work, structural steel, reinforced concrete; expert in steam handling; holds first-class engineers' license for Massachusetts. Accustomed to handling men, purchase of material and equipment, and office work. Can give best references.

185 Member desires change of position with opportunity to make full use of engineering training and practical experience. Thoroughly familiar with all machine shop operations and practices, designing, various lines of mechanical products and the tools for their interchangeable manufacture. Assistant superintendent or in engineering capacity.

186 Graduate mechanical engineer, age 36, desires permanent position in or near New York. Excellent experience in engineering, purchasing and sales work

with consulting, manufacturing and selling concerns. At present employed in executive sales position, but desires to change for better and more permanent work.

187 Junior member, age 27, at present with large Eastern concern manufacturing a general line of brass goods, as designing engineer on tools, fixtures, special automatic and pneumatic machinery, experienced tool maker and machinist, desires position with manufacturing concern in Connecticut, as designing engineer or master mechanic.

188 Mechanical engineer with practical machine shop experience, technical education, three years' experience in elevating, conveying, mine and power transmission machinery, desires position as sales engineer with firm or representative located in Pittsburgh.

189 Superintendent or works manager; fifteen years' experience in the manufacture of light and heavy engines, machine tools and various lines of merchandise, and connected with the factory division of a very large mail order house for the past two years. Has had broad experience in establishing and maintenance of premium and piece work plan of wage payment.

190 Executive engineer, member, age 37, seventeen years' broad and diversified experience in engineering, organization and general business, at present manager of large industrial plant, will consider new connection with a big proposition requiring both executive and engineering ability.

191 Junior, age 30, single, with technical training and experience in design and construction of high voltage transmission lines and substations, also experienced in hydrograph computations, would like to make connections with large firm doing hydroelectric work. Salary according to requirements of position.

192 Sales engineer desires position where a knowledge of machinery and mill supply trade in United States and Canada is essential; seven years' varied engineering experience, nine years in selling end. Experience in correspondence and design of selling contracts.

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